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IMPACT OF VERMICOMPOST AND FOLIAR SPRAY OF VERMIWASH ON GROWTH, YIELD AND NUTRITIONAL STATUS OF LETTUCE PLANTS

Yassen A.A.[1]*, Entsar M. Essa[1], Neama M. Marzouk[2] and Sahar M. Zaghloul[1]

[1*]Plant Nutrition Department, National Research Centre,.33 El- Behooth St. P.O. 12622. Dokki, Cairo, Egypt
[2]Vegetable Research Department, National Research Centre,.33 El- Behooth St. P.O. 12622. Dokki, Cairo, Egypt

Abstract

A field experiments were carried out in two seasons of 2017 and 2018 at the Experimental Station of the National Research Centre in Nubaria region, Egypt. In order to study the effect of vermicompost fertilizer at the rate of (0,2 and 4 ton fed^{-1}) and foliar spray of vermiwash (50-100 and 150 ml/ L) in combination to improve vegetative growth (plant height, number of leaves, leaf area, fresh and dry weight of leaves and head, head diameter and total yield ton fed $^{-1}$), yield and chemical composition of lettuce plants. Results showed that vermicompost fertilizer at 4 ton fed^{-1} surpassed vermicompost fertilizer at 2 ton fed-$^{-1}$ in increasing all growth parameters, yield and leaf mineral content. Meanwhile vermicompost fertilizer combined with vermiwash trended to increase all growth parameters and yield in comparison with the application of each them and the control. Most treatments under study significantly increased most leaf mineral content and uptake (N, P, K, Mg, Fe, Zn and Mn) in leaves and head of lettuce plants. On the other hand, all treatments had no effect of leaf Ca percentage and uptake in leaves and head lettuce plants. In addition, vermicompost fertilizer at 4 ton fed^{-1} combination vermiwash at (50-100 and150 ml/ L) foliar spray could be safely recommended for improving most vegetative growth, yield and nutrition status of lettuce plants.

Key words : vermicompost and vermiwash fertilizer- vegetative growth - nutritional status –Lettuce plants.

Introduction

In recent years, alteration, in ways of lifestyle and dietary habits have led to increase demand on fresh vegetables as rustle of consumers' desire to obtain healthy and palatable food. Leaves of lettuce (*Lactuca sativa* L.) is the most popular used for salad and other kinds of food, such as soups, sandwiches and wraps; it can also be grilled. This popularity has led to an augmentation in lettuce production and consumption in the world especially in Egypt. The content of lettuce Leaves are rich in vitamins, minerals, sugars, folic acid, and dietary antioxidants and low in calories Nicolle *et al.*, 2004. The everyday consumption of leafy vegetables lowers the risk of cancer and heart diseases, have anti-inflammatory properties, protects neuronal cells, prevents tiredness and prevents senescence(Or³owski, 1999).

Organic agriculture is the form of agriculture that relies on crop rotation, green manure, compost, biological pest control. Organic materials are always recommended to regenerate soil fertility and reduce negative environmental impact compared to chemical fertilizers, which may degrade organic carbon and humus, destroy soil structure, and cause toxicity in plants, which in turn causes spread of some illnesses, such as cancer. Leafy vegetables respond well to organic fertilizers such as lettuce and spinach (Nardi *et al.*, 2004 Chaterjee *et al.*, 2005, Zhao *et al.*, 2009 and Oliveira *et al.*, 2010). Biological agriculture is an element of the system for sustainable agriculture and an alternative to traditional approaches in agriculture. Biological agriculture (vermicompost) is the products obtained as a result of composting of organic waste with the help of various types of earthworms (Clive *et al.*, 2006, Gutiérrez-Miceli *et al.*, 2007, Singh *et al.*, 2008). Vermicomposting generally converts organic matter to a more uniform size, which gives the final substrate a characteristic earthy

***Author for correspondence :** E-mail: azimyassen@yahoo.com

appearance, whereas the material resulting from composting usually has a more heterogeneous appearance (Tognetti *et al.,* 2005). Addition of Vermicompost as slow release of nutrients from organic matter, increases microbial populations and keeps fertility of the soil especially in sandy soils as compared to chemical fertilizer. Romero 2002 and Chanda *et al.,* 2011. Vermicompost proved its superiority in enhancing leaf yield of lettuce over farmyard manure and sheep manure whether used as a sole application or in conjunction with inorganic fertilizers Asif M Rather *et al.,* 2018. Vermiwash is liquid fertilizer contains several enzymes, plant growth hormones like cytokinins, gibberlines and vitamins along with micro- and macronutrients. It is used in organic agriculture both as replacement and supplement for solids to provide nutrients effectively and quickly to enhance plant growth and crop productivity through foliar spray. Vermiwash is less costly, easily available, time saver, and environmentally safely (Subasashri 2003, Gamaley *et al.,* 2006, Weersinghe *et al.,* 2006, Zambare *et al.,* 2008 ;Gorakh and Singh 2009, Varghese and Prabha 2014 and Fathima and Sekar 2014. Sobha *et al.,* (2003) found that foliar application of vermiwash has promoted plant physiology that ultimately caused higher yield and quality of crops.

This study worked to investigate the benefits of different rates of vermicompost and foliar application of vermiwash on vegetative growth, yield and nutritional status of lettuce plants in field.

Materials and Methods

A field experiment was conducted during two successive seasons at the experimental station of the National Research Centre in Nubaria region, Egypt, to evaluate the performance of different rates of vermicompost and foliar spray of vermiwash on vegetative growth, yield and nutritional status of Lettuce plants. Soil sample from the experimental field was air dried and passed through a 2-mm sieve and stored for laboratory analysis and recorded in Table 1. The physical and chemical properties of soil were determined according to Klute (1986) and Page *et al.,* (1982).

Seedlings were transplanted when two leaves were completely expanded 30 days after sowing Seeds of lettuce (*Lactuca sativa* L.) cv Dark Green, were obtained from Vegetable Department, Ministry of Agriculture. Seedlings were set up in the field on 30th of October and 7th of November in the first and second seasons, respectively. Seedlings were planted on one side of ridges 25cm apart, ridges were 80 cm in width and 4 m length. Each plot included 4 ridges and the plot area was about 12 m^2.

The analysis of vermicompost which made from plant residue: pH 6.90, EC (dS m^{-1}) 2.00, Moisture content (%)15, Organic matter (%)45.3, Organic carbon (%)26.3, Ash (%)54.7, C/N ratio 1:23.9, N (%)1.10, P (%)0.30, K (%)0.90.

The treatments consisted of plant residue vermicompost with different concentrations of rates (Zero, 2 and 4 ton fed^{-1}) and incorporated in the top 15 cm layer of soil in the experimental beds before the plantation of lettuce seedlings. The recommended dose of NPK chemical fertilizers used in this experiment according to the Ministry of Agriculture, Egypt. Foliar spray of vermiwash fertilizers at rates of (5, 10 and 15%) three sprays at 2 weeks intervals were used. Vermiwash was mixed with water to get the desired concentration. The experimental treatments were as follows:

1. T_1 :Control (without vermicompost)
2. T_2 :Vermicompost at 2 ton fed^{-1}
3. T_3 :Vermicompost at 2 ton fed^{-1}+ Vermiwash 50ml/ L (5%) foliar application
4. T_4 :Vermicompost at 2 ton fed^{-1}+Vermiwash 100ml/ L(10%)foliar application
5. T_5 :Vermicompost at 2 ton fed^{-1}+Vermiwash 150ml/ L(15%)foliar application
6. T_6 :Vermicompost at 4 ton fed^{-1}
7. T_7: Vermicompost at 4 ton fed^{-1}+ Vermiwash 50ml / L (5%) foliar application.
8. T_8: Vermicompost at 4 ton fed^{-1}+Vermiwash 100ml/ L (10%) foliar application
9. T_9: Vermicompost at 4 ton fed^{-1}+Vermiwash 150ml/ L (15%) foliar application

The experiments were arranged in randomized block design with five replicates. All agricultural practices operation - other than experimental treatments- necessary for growth as cultivation, irrigation and pest control were followed whenever it was necessary and were done according to the

Table 1: Chemical and physical characteristics of the investigated soil.

Mechanical analysis									
Sand %	Silt %	Clay %	Texture class						
92.65	5.07	2.28	Sandy loam						
Available nutrients (mg/kg)									
pH	EC dSm^{-1}	N	P	K	Fe	Mn	Zn	Mg	$CaCo_3$ %
7.88	1.64	25.58	11.58	1.74	2.52	4.71	0.21	8.41	3.25

recommendations of Ministry of Agriculture, Egypt.

Recorded data

After 60 days from transplanting, the plants were harvested and total yield was recorded for each plot. Three plants were randomly chosen from each experimental plot to determine plant height (cm), number of leaves/plant, leaf area cm^2, fresh weight g $plant^{-1}$, dry weight g $plant^{-1}$, head fresh weight, head dry weight, head diameter and total yield ton fed^{-1}

Chemical constituents

The percentage of N, P, K and Ca in leaves and head were determined according to the methods in (Cottenie *et al.*, 1982). Zinc, manganese, iron content were determined using atomic absorption spectrophotometer as described by Cottenie *et al.*, (1982)

Statistical analysis

All data obtained during each season were subjected to analysis of variance according to Snedecor and Cochran 1980. The least significant differences (LSD) at P= 0.05 level was used to verify the difference between means of the treatments.

Results and Discussion

Growth parameters

In this study the effect of different rates of vermicompost fertilizer (2 and 4 ton fed^{-1}) with foliar application of vermiwash on growth parameters and yield of lettuce plants are presented in (Table 2). The experimental results revealed that treatment T9: (vermicompost at 4 ton fed^{-1}+Vermiwash 150ml/ L foliar application) as well as treatment T_8: (vermicompost at 4 ton fed^{-1} +vermiwash 100ml/ L foliar application) significantly increased all parameters under study as compared to other treatments and control. Meanwhile, combined treatments caused the highest effect in increasing all vegetative growth and yield under study followed by vermicompost at 4 ton fed^{-1} then vermicompost at 2 ton fed^{-1} treatment while, the lowest increase was obtained from vermicompost at 2 ton fed^{-1} and control.

In addition, vermicompost fertilizer at the rate of (4 ton fed^{-1}) showed the highest value in most parameters as compared with adding (2 ton fed^{-1}). The maximum-recorded values were 29.87 and 26.51 plant height (cm), 36.00 and 28.67 number of leaves/plant, 245.47 and 220.67-leaf area mm^2, 406.80 and 356.03 fresh matter g $plant^{-1}$, 74.49 and 356.03 dry matter g $plant^{-1}$, 279.49 and 244.41 head fresh matter, 37.03 and 35.73 head dry matter and 14.10 and 13.18 total yield ton fed^{-1} respectively. The increase of growth parameters and yield was due to the complete decomposition of vermicompost and release of nutrients in available form and also, to the extensive increments in soil microbial biomass after vermicompost addition which stimulated the action of hormones or humates in the vermicompost as plant-growth regulators independent of alimentation supply. These results agreed with finding of Vernieri, 2002 and Ali *et al.*, 2007. They concluded that soil fertilizer with vermicompost increased heads and yield of lettuce plants.

In general, vermicompost fertilizer treatments as soil application combined with vermiwash foliar application trended to increase all growth parameters and yield in comparison with the application of other treatments. Yadav, *et al.*, 2005; Ansari. (2008 a) Ansari and Sukhraj 2010;. Kaur and Babbar 2015 and Verma, 2017.

Apparently, the differences between foliar spraying of vermiwash (5% -10% and 15%) on lettuce plants, presented in table (2) demonstrated that the highest values of most measurements of vegetative growth characters had pronounced effect and progressively increased when adding 15% of vermiwash with vermicompost fertilizer as compared with 5% and 10% of foliar spraying of vermiwash with vermicompost. These findings confirm those obtained by (Mahto and Yadav, 2005 and Manyuchi *et al.*, (2013) who found that combined uses of vermicompost + vermiwash have higher fresh yield of vegetable pea and maize plant over control. In addition, Kaleena *et al.*, (2013) they found that foliar sprayed with vermiwash increased maximum vegetative growth parameter increased of okra Devasinghe *et al.*, (2016) indicated that spraying with vermiwash at higher rate significantly increased vegetative growth compared to control in lettuce plants. Because vermiwash also rich in macro and micronutrients.

Chemical composition

The data in (Table 3, 4, 5) revealed that all treatments under study increased N, P, K, Mg, Fe, Zn and Mn content (%) and uptake (mg/plant) in leaves and head of lettuce plants over the control (without vermicompost). However, as treatment T_8 (vermicompost at 4 ton fed^{-1} +vermiwash 100ml/ L foliar application) gave the highest significant percentage of N, P, K, and Mg in leaves as well as N content in heads compared with the other used treatments and the control (Table 3). Meanwhile, treatment T_9 (vermicompost at 4 ton fed^{-1} +Vermiwash 150ml/ L foliar application) gave the richest head P, K and Mg content (Table 3). In addition, treatment T_9 (vermicompost at 4 ton fed^{-1} + vermiwash 150ml/ L foliar application) had higher amount of N, P and K uptake (mg/plant) in leaves

Table 2: Effect of different rates of vermicompost fertilizer with foliar application of Vermiwash ong rowth parameter and yield of Lettuce plants (Average of two seasons).

Treatments	Plant height (cm)	Number of leaves /plant	leaf area mm^2	Fresh matter of leaves g $plant^{-1}$	Dry matter of leaves g $plant^{-1}$	Head diameter	Head Fresh matter (g)	Head dry matter (g)	Total yield ton/Fed
T_1	23.68	26.33	188	288.55	55.24	15.12	218.74	31.29	10.40
T_2	26.51	28.67	220	356.03	67.66	17.46	244.41	35.73	13.18
T_3	30.11	35.67	249	370.57	71.51	19.27	263.42	40.60	15.65
T_4	33.73	38.00	263	384.93	75.14	21.17	288.70	42.61	16.33
T_5	31.89	40.33	274	390.14	78.55	22.59	300.36	42.85	15.92
T_6	29.87	36.00	245	406.80	74.49	20.13	279.49	37.03	14.10
T_7	34.52	43.67	275	405.84	81.76	23.76	300.09	40.10	17.88
T_8	37.44	44.00	288	432.49	85.28	25.17	321.44	45.93	18.84
T_9	38.11	44.67	290	425.58	87.10	26.02	314.35	42.68	19.06
LSD 5%	2.17	1.69	21.82	23.99	3.14	2.51	12.65	3.55	1.39

Table 3: Effect of different rates of vermicompost fertilizer and foliar spray vermiwashon N, P, K, Ca and Mg content (%) in leaves and head of lettuce plants(Average of two seasons).

Treatments	leaves					Head				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg
	%									
T_1	1.65	0.38	1.71	0.68	0.27	1.34	0.23	1.22	1.68	0.21
T_2	1.72	0.42	1.83	0.38	0.28	1.42	0.25	132	1.1	0.23
T_3	1.89	0.53	1.90	0.38	0.35	1.49	0.26	1.46	1.12	0.25
T_4	2.19	0.55	2.26	0.40	0.39	1.68	0.26	1.77	1.13	0.30
T_5	2.08	0.54	2.14	0.40	0.36	1.73	0.31	1.80	1.18	0.28
T_6	2.11	0.46	2.00	0.42	0.31	1.55	0.28	1.60	1.15	0.23
T_7	2.23	0.57	2.00	0.40	0.37	1.63	0.28	1.75	1.18	0.26
T_8	2.76	0.61	2.51	0.43	0.45	1.94	0.32	1.83	1.2	0.33
T_9	2.60	0.55	2.36	0.40	0.40	1.80	0.33	1.95	1.15	0.34

Table 4: Effect of different rates of vermicompost fertilizer and foliar spray vermiwash on N, P, K, Ca and Mg uptake mg/plant in leaves and head of lettuce plants(Average of two seasons).

Treatments	leaves					Head				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg
	Uptake mg/plant									
T_1	911.46	209.91	944.60	375.63	149.15	419.29	71.97	381.74	525.67	65.71
T_2	1163.75	284.17	1238.18	257.11	189.45	507.37	89.33	471.64	393.03	82.18
T_3	1351.54	379.00	1358.69	271.74	250.29	604.94	105.56	592.76	454.72	101.50
T_4	1645.57	413.27	1698.16	300.56	293.05	715.85	110.79	754.20	481.49	127.83
T_5	1633.84	424.17	1680.97	314.20	282.78	741.31	132.84	771.30	505.63	119.98
T_6	1571.74	342.65	1489.80	312.86	230.92	573.97	103.68	592.48	425.85	85.17
T_7	1823.25	466.03	1635.20	327.04	302.51	653.63	112.28	701.75	473.18	104.26
T_8	2353.73	520.21	2140.53	366.70	383.76	891.04	146.98	840.52	551.16	151.57
T_9	2264.60	479.05	2055.56	348.40	348.40	768.24	140.84	832.26	490.82	145.11

of lettuce, plants as compared with the other used treatments and the control (Table 4). Also, treatment T_8 (vermicompost at 4 ton fed^{-1} +vermiwash 100ml/ L foliar application) increased N, P, K and Mg uptake in head as well as Mg uptake (mg/plant) in leaves as compared with that in all other treatments and the control (Table 4). As

Table 5: Effect of different rates of vermicompost fertilizer and foliar spray vermiwash on Fe, Zn, and Mn content (ppm) and uptake (mg/plant) in leaves and head of lettuce plants.(Average of two seasons).

Treatments	leaves						Head					
	Fe		Zn		Mn		Fe		Zn		Mn	
	ppm	Uptake mg/plant	ppm	Uptake mg/plant	ppm	Uptake mg/plant	ppm	Uptake mg/plant	ppm	Uptake mg/plant	ppm	Uptake mg/plant
T_1	122.5	6766.9	34.3	1894.7	58.1	3209.4	97.2	5369.3	22.4	1237.4	33.8	1867.1
T_2	156.8	10609.1	36.6	2476.4	64.7	4377.6	122.6	8295.1	27.8	1880.9	40.0	2706.4
T_3	163.5	11691.9	38.0	2717.4	64.0	4576.6	130.2	9310.6	33.4	2388.4	43.5	3110.7
T_4	188.8	14186.4	40.0	3005.6	70.4	5289.9	133.9	10061.2	34.6	2599.8	50.0	3757.0
T_5	175.7	13801.2	39.4	3094.9	68.0	5341.4	140.8	11059.8	36.4	2859.2	50.0	3927.5
T_6	174.3	12983.6	42.2	3143.5	74.7	5564.4	135.0	10056.2	30.9	2301.7	48.1	3583.0
T_7	194.5	15902.3	48.8	3989.9	82.1	6712.5	145.1	11863.4	35.5	2902.5	50.0	4088.0
T_8	213.1	18173.2	58.1	4954.8	91.3	7786.1	155.8	13286.6	44.0	3752.3	56.8	4843.9
T_9	206.5	17986.2	55.0	4790.5	86.8	7560.3	164.9	14362.8	38.4	3344.6	51.3	4468.2

for eaves and head Ca content and uptake of lettuce plants (Table 3, 4) displays that has no noticed effect among all treatments used under study in this respect. Also, treatment T_8 (vermicompost at 4 ton fed^{-1} +vermiwash 100ml/ L foliar application) gave the highest increased Fe, Zn and Mn content (ppm) and uptake (mg/ plant) in leaves as well as Zn and Mn content (ppm) and uptake (mg/plant) in head as compared with the other used treatments and the control (Table 5). Treatment T_9 (vermicompost at 4 ton fed^{-1} + vermiwash 150ml/ L foliar application) richest head Fe content (ppm) and uptake (mg/plant) of lettuce plants (Table 5).

Generally, most treatments of lettuce plants in the present study increased most mineral content and uptake in leaves and head under study except Ca a compared with that of the control. Vermicompost at 4 ton fed^{-1} +vermiwash 150ml/ L foliar application is important for inducing an increase in most leaf nutrient content in both leaves and head lettuce plants. Meanwhile, vermicompost at 2 ton fed^{-1} +vermiwash 150ml/ L foliar application Fe ranked second. These results are in general agreed with the finding Bellitürk *et al.,* (2017). In addition, Adriana Hernández, *et al.*, (2010) who illustrated that vermicompost fertilizer and foliar application of vermiwash led to increase in N, P, K, Mg, Fe, Zn and Mn content and uptake and lower Ca in lettuce leaves which can be an advantage for using vermicompost as compared with traditional compost. Bai and Malakout 2007, on onion, Prabha *et al.,* 2007 on tomatoes and Wang *et al.,* (2010) on Chinese cabbage conducted experiments to assess the effect of increasing doses of vermicompost applications and found significant increase in the nutritional value. Also, it is obvious that the application of vermicompost at 4 ton fed-^{1} +Vermiwash 150 ml/L increased concentration and uptake of N, P, K Mg Fe and Zn in head of lettuce plants compared to vermicompost at 4 ton fed-^{1} + vermiwash 150 ml/ L. whereas, the reverse was noticed in leaves of lettuce plants.

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