Assiut J. Agric. Sci., 52 (3) 2021 (69-81) **ISSN: 1110-0486**
Website: www.aun.edu.eg/faculty_agriculture/journals_issues_form.php **E-mail: ajas@aun.edu.eg**

Effect of Organic Liquid Vermicompost as a Substitute for Chemical Fertilizer on Morphological and Biochemical Characteristics in Lettuce

***Helaly, Amira A.[1] and Rehab A. El-Dakak[2]**

[1]Department of Vegetable crop, Faculty of Agriculture, Alexandria University, Egypt.
[2]Department of Botany and Microbiology, Faculty of Science, Alexandria University, Egypt.
*Corresponding author: amira.helaly@alexu.edu.eg

Accepted for publication on: 31/10/2021

Abstract

The use of organic vermicompost fertilizers is considered one of the promising fertilizer. Therefore, the experiment aimed to study the effect of using liquid vermicompost fertilizer as an alternative to chemical fertilizers in the production of lettuce, Crisp head variety. In this study, a field experiment was conducted during the two winter seasons of 2019-2020 and 2020-2021 at the Agricultural Research Station in the Abies region, affiliated to the Faculty of Agriculture, Alexandria University Egypt. This experiment aimed to evaluate the response of lettuce plants to the application of liquid vermicompost (LVC) fertilizer through four different concentrations (2.5%, 5%, 10%, and 20%), and the chemical fertilization treatment (100% NPK) in the recommended rate as a control treatment for lettuce production, on some vegetative growth characters; Fresh weight plant^{-1} (kg), head net weight plant^{-1} (kg), total yield fed^{-1} (ton), and unmarketable yield fed^{-1} (ton), in addition to some biochemical characteristics; vitamin C, dry matter, total soluble solids, and carbohydrates as well as estimate the element content and quality elements, such as nitrogen (N^+), potassium (K^+), phosphorus (P^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), and iron (Fe^{2+}). The results showed a gradual significant increasing in the values of most of the studied traits by increasing the concentrations of vermicompost fertilizer from 2.5 % to 20%. The application of vermicompost treatment with a concentration of 20% LVC gave the highest significant values for most of the studied traits without a clear significant difference compared to the chemical fertilizer 100% NPK.

Keywords: *Liquid vermicompost, Lettuce, Recycling of organic waste, Red wiggler worms.*

Introduction

In recent years, changes in lifestyle and eating habits have led to an increase in demand for fresh vegetables, which is a consumer's desire for healthy and appetizing foods. Lettuce (*Lactuca sativa* L.) is Egypt's and the world's most popular vegetable salad. Lettuce is rich in phytochemicals, which are anticancer drugs, as well as vitamins A & C, antioxidants minerals, sugars, and folic acid (Kim *et. al.* 2016 a). Lettuce also provides small amounts of fiber, carbohydrates, protein, and fat. Lettuce has become a major commercial crop in the household market (Kim *et. al.* 2016 b).

The use of organic fertilizer alternatives helps to eliminate or reduce the careless use of chemical fertilizers, which negatively affects the ecological balance and increases production costs. In lettuce crops, organic farming can play an essential role in reducing the amount of toxic compounds (eg. nitrates), thereby improving leaf quality, maximizing yields and profits (León *et. al.* 2012) vermicomposting is a cost-effective and eco-friendly process used to treat organic waste that undergoes biodegradation and medium temperature stability through the interaction of microorganisms and earthworms, from which vermicompost is produced. This product is rich in organic compounds, microorganisms, mineral nutrients, plant hormones, and humic acid. Thereby improving its applicability to agricultural practice (Kim *et. al.* 2014 and Belliturk. 2018). Earthworm compost is not only economical and environmentally friendly but also conducive to the maintenance of the soil environment. Continued use of chemical fertilizers can cause health and environmental hazards, such as groundwater and surface water pollution by nitrate leaching (Zambare *et. al.* 2008). The stimulation of plant growth may mainly depend on the biological characteristics of vermicompost, the types of plants used, and the growth conditions. Increasing the amount of humus in the soil by applying pest compost through earthworms will certainly contribute to favorable changes in soil physical, chemical, and biological properties, and improve water retention capacity (Singh *et. al.* 2011). Considering the complex and variable composition of vermicompost concerning the inorganic matter.

Vermicompost contains highly enhanced nutrients, particularly nitrogen, which plants gradually absorb (Atiyeh *et. al.* 2000). Due to a reduction in electrical conductivity, vermicompost treatment in the soil promotes the retention of nitrogen and the progressive release of phosphorus, resulting in enhanced agricultural substrates (Lazcanoa and Dominguez, 2011).

Liquids vermicompost fertilizer is rich in nutrients that aid plant development and metabolism. It improved tomato and other crop germination, growth, flowering, and yields in a similar way to solid vermicompost (Tejada *et. al.* 2008). Researchers have defined numerous terminologies to describe the vermicomposting produced liquids based on their preparation process. Vermiwash, vermi-leachate, worm bed leachate, and worm tea are some of the most frequent ones (Ismail, 1997). When applied to the same crops, these aqueous vermicompost extracts are easier to carry and apply than solid vermicompost, and they can duplicate most of the benefits of vermicompost.

The purpose of this study was to evaluate the growth of lettuce plants (*Lactuca sativa* L.) treated with several different ratios of liquid vermicompost as organic fertilizer, and compared them to the recommended rate of conventional chemical fertilizers.

Material and Methods

A field experiment was conducted during two successive winter seasons of 2019-2020 and 2020-2021 at the Agricultural Research and Experiment Station in Abies region, Faculty of Agriculture, Alexandria University Egypt, to evaluate the performance of different concentrations of organic liquid vermicompost fertilizer compare with the recommended rate of chemical fertilizer on vegetative growth, yield and nutritional status of lettuce plants.

Plant Material and Cultivation.

This experiment was prepared on crisp head lettuce, often known as iceberg lettuce, which is a compact, spherical lettuce with overlapping leaves. The internal leaves are paler and sweeter. In both seasons, the seeds were sown in the nursery on the first of October, then the seedlings were transferred to the open field on the tenth of November after the field plan for the experiment had been prepared. The treatments were arranged randomly and the design of the experiment was the randomized complete blocks design (RCBD) with three replications, each replica containing five plots, for the five treatments as follows, (1) 2.5% LVC - (2) 5% LVC - (3) 10% LVC - (4) 20% LVC - (5) 100% NPK as the recommended rate of chemical fertilization. The area was 28 m^2 with 10 rows, the length of the row was 3 meters and its width was 0.7 meters. At a distance of 25 cm, the seedlings were planted. The organic liquid vermicompost (LVC) was added to the lettuce plants by injection to the soil next to the plants. The addition of different concentrations of organic liquid vermicompost fertilizer to the experimental units was applied after two weeks from the transplanting date. Liquid vermicompost concentrations were added once every two weeks for three times, while the addition of the recommended chemical fertilizer rate per fed. was divided as one of the applied treatments to compare it with the concentrations of vermicompost fertilizer used in the study in two batches, as follows: 150 kg of ammonia nitrate, 100 kg of calcium nitrate, and 100 kg of potassium sulfate, at the same dates of adding vermicompost treatments, while adding a dose of calcium nitrate once with the second batch of fertilization, according to the recommendations of the Egyptian Ministry of Agriculture. All agricultural practices necessary for growth, such as regular irrigation and pest control, were followed whenever possible and in accordance with the recommendations of the Egyptian Ministry of Agriculture.

Soil samples from the experimental area's surface layers were taken and prepared for analysis in the Plant Nutrition Laboratory, Soil, Water and Environmental Research, Faculty of Agriculture, before the commencement of each experiment. According to the methods outlined by Page *et. al.* (1982). The soil analysis results are shown in Table (A).

Table (A). Physical and chemical characteristics of the experimental site of the two seasons.

Winter seasons	Soil type	EC (ds m^{-1})	pH	O.M (%)	HCO^{-3} (meq L^{-1})	CL^- (meq L^{-1})	Na^+ (meq L^{-1})	Available N, P and K (mg g^{-1})		
								N	P	K
Season 1	Clay	2.56	8.16	1.1	4.62	10.4	15.66	96	19	570
Season 2	Clay	2.31	7.95	1.3	4.53	10.6	16.13	93	22	595

Vermicompost preparation steps.

The vermicompost fertilizer used in the experiment was produced in The Organic Vermicompost Production Unit Pic.(1) of the Agricultural Research and Experiment Station in Abeis area, Faculty of Agriculture, Alexandria University, according to Quaik *et. al.* (2016).

Pic. 1. The Organic Vermicompost Production Unit.

a- Solid vermicompost breeding unit.
b- Agriculture and animal wastes fermentation process.
c- Breeding unit filled with organic material such as rice straw and vegetable waste.
d & e- Breeding units filled with solid vermicompost
f- Organic liquid vermicompost fertilizer.

Organic liquid vermicompost fertilizer was prepared from the natural organic solid waste by using a shredding machine for agriculture and animal wastes then starting the fermentation process within approximately one week in the separate breeding unit to keep balanced content of nitrogen and pH ranged from (6.5 -7). Each breeding unit will be filled with organic material such as rice straw and tree leaves. Place one layer of shredded and fermented natural organic solid (plant and animal wastes) per breeding unit with a thickness of 150 mm.

Based on the literature survey, the most productive and common type of earthworms was red wigglers worms "*Eisenia foetida*" which has a high and rapid reproduction rate. Two kilograms of red wigglers worms will be supplied to each breeding unit then; each unit will be covered by coarse jute. The spraying technique (water sprinklers) was used daily to keep moisture content up to 70-80%.

From the second month to the fourth month, the multi-stage filtration system will be used to obtain clean liquid vermicompost. Leachate comes out due to water spraying of solid vermicompost in each breeding unit. All breeding units are connected to a drainage line linked by a tank with a 500-liter capacity to collect liquid vermicompost after filtration and adjust pH level and electrical conductivity (EC) to be 5.8, +14 respectively. And then the filter was used to clean liquid vermicompost. The vermicompost was analyzed to measure the concentration of elemental composition content and pH level by Central Laboratory, Faculty of Agriculture, Alexandria University. Table (1). Summarizes the chemical and physical properties of the vermicompost used in the experiments.

Table 1. The chemical properties of the organic liquid vermicompost extract used in the experiments.

Total nitrogen	15 %	Calcium	200.8 mg l^{-1}
Phosphorus	6.35 %	Magnesium	293.0 mg l^{-1}
Potassium	7.15 %	Manganese	183.0 mg l^{-1}
Organic matter	45.3 %	Sodium	14.8 mg l^{-1}
Organic Carbon	27 %	Boron	3.0 mg l^{-1}
C/N ratio	1:25	Zinc	280.0 mg/l
Electrical conductivity	2.00 dS m^{-1}	Iron	99.0 mg l^{-1}
pH	6.56	Chloride	3.0 mg l^{-1}

-The analysis of chemical instructions was carried out in the Central Laboratory, Faculty of Agriculture, Alexandria University.

Data recorder

Morphological parameters.

Seventy days after transplanting, (at harvest period), five plants were randomly selected from each plot for measurement: 1- Fresh weight plant^{-1} (kg), 2- head net weight plant^{-1} (kg), 3- total yield fed^{-1} (ton), and 4- unmarketable yield fed^{-1} (ton).

Biochemical constituents.

A fresh sample of lettuce leaves was prepared for the determination of vitamin C, and carbohydrates according to the method reported in A.O.A.C. (2000), in addition to the estimate of total soluble solid TSS (%) by using a Digital Refractometer (Pocket Refractometer ATAGO CO., LTD), as well as estimation of the percentage of dry matter in leaves by preparing well-cut samples, then placed in an air-forced oven at a 70°C for 72 hours until constant weight and then weighed to estimate the percentage of dry matter.

The prepared dry samples were used to estimate the element content and quality elements, such as nitrogen (N^{+}) potassium (K^{+}), phosphorus (P^{+}), calcium (Ca^{2+}), magnesium (Mg^{2+}), and iron (Fe^{2+}) contents in combined leaves of head lettuce plants were carried out according to A.O.A.C. (2016).

Statistical analysis

Using the computer application Co-Stat Software version 2004, all measured variables were subjected to analysis of variance (ANOVA) to find any statistically significant differences. Duncan's multiple range tests were used to compare the means of the different treatments at a probability level of 0.05 (Steel and Torrie 1980).

Results and Discussion

Vegetative growth parameters.

In order to study the effect of liquid vermicompost fertilizer (LVC) with different concentrations (2.5%, 5%, 10%, and 20%), compared to the recommended rate (100% NPK) of chemical fertilizer for producing lettuce as a control treatment, on improving the vegetative growth characteristics of lettuce plants; fresh weight plant^{-1} (kg), the net head weight. plant^{-1} (kg), total yield. fed^{-1} (ton), and un-marketable yield. fed^{-1} (ton) during both seasons Fig. (1). Vermicompost at a concentration of 20% LVC improves plant growth parameters; fresh weight. plant^{-1} (kg), head net weight. plant^{-1} (kg), and total yield. fed^{-1} (ton). At the same time, there was no significant difference between the values recorded for the same traits for both treatments of liquid vermicompost at 20% and 100% NPK during the two growing seasons, respectively. While the same two treatments 20% LVC and chemical fertilization 100% NPK recorded the lowest values without significant difference between them for the un-marketable yield. fed^{-1} in both seasons. While there was a gradual significant decrease in the values of all traits with a decrease in liquid vermicompost concentrations from 20% LVC to 2.5% LVC, except for the un-marketable yield fed^{-1}, which increased by decreasing those concentrations during the two growing seasons. This might be owing to the increased nitrogen concentration in the soil as a result of the vermicompost application in this experiment (Table 1). According to Singh and Varshney (2013), vermicompost instantly enhanced soil NH_4^+- N and NO_3- N levels. Vermicompost can also promote the development of nitrogen-fixing microorganisms in the rhizosphere, increasing N availability by bringing biologically fixed nitrogen into the soil through close mixing (Mackay *et al.,* 1982). Later research by Arancon et al. (2003) suggested that the increases in crop development and fruit yields may be attributed in part to a substantial increase in soil microbial biomass following vermicompost application, resulting in higher hormones or humate content in the vermicompost treatment. The obtained results also agreed with (Eker, 2016), who found that vermicompost has been shown to improve the growth, productivity, and quality of field-vegetable crops in several experiments and also improves the quality of ornamental plants. According to Vadiraj and Potty (1998), vermicompost application resulted in coriander cultivar herbage yields that were comparable to those obtained with chemical fertilizers. Similarly, when vermicompost was applied to other field crops, such as Sorghum bicolor, a positive reaction was found (Patil and Sheelavantar, 2000). As well as vermicompost which contains biologically active substrates such as plant growth regulators is considered an organic amendment that can be hosting beneficial microorganisms, which in turn facilitate soil enzymatic activities (Sinha *et. al*. 2010).

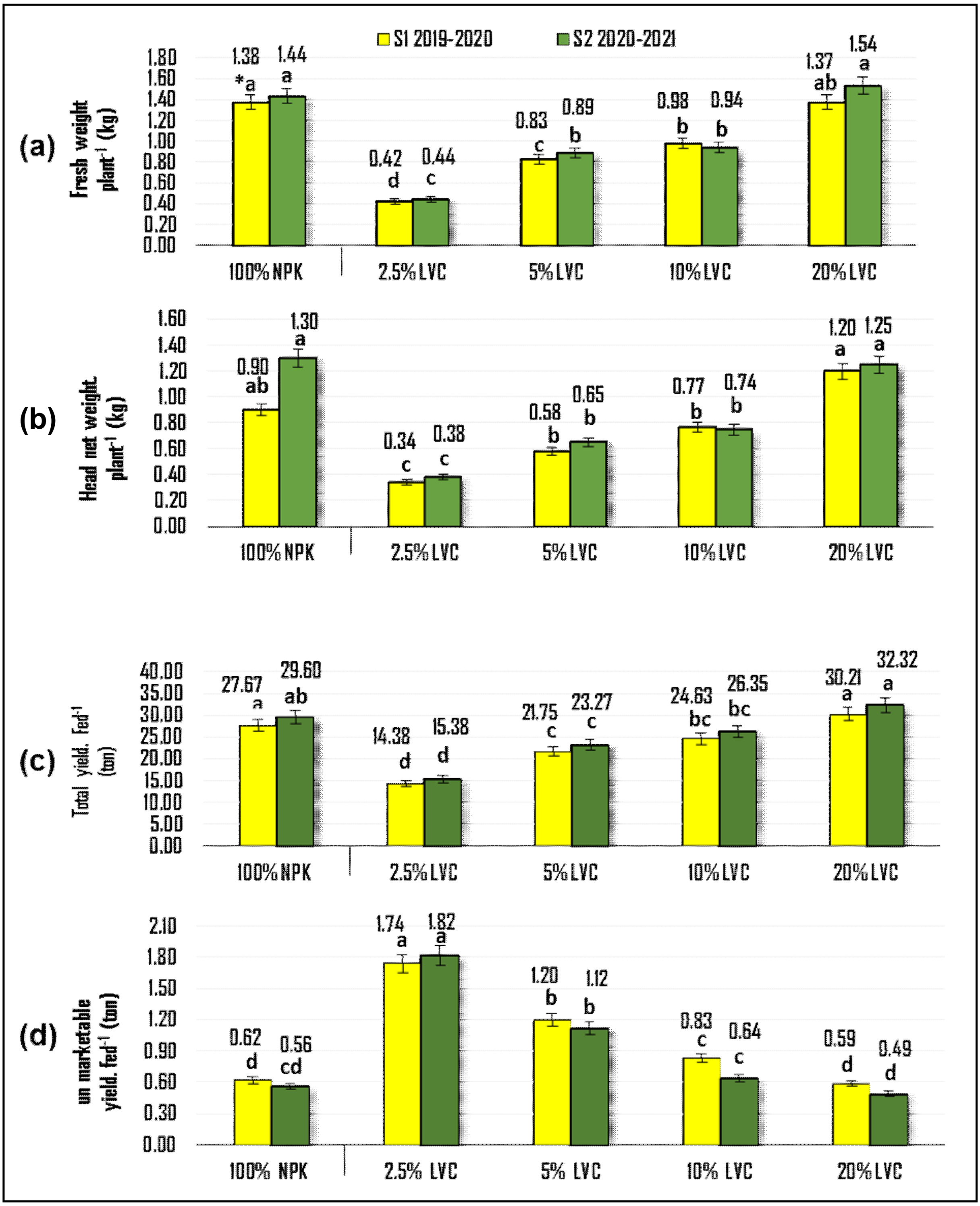

Fig. 1. Vegetative growth parameters of lettuce plants at 70 days (harvest stage), as affected by different concentrations of liquid vermicomposting, and recommended rate of NPK as a chemical fertilizer. (a) Fresh weight plant^{-1} (kg), (b) Head net weight. plant^{-1} (kg), (c) Total yield. Fed^{-1} (ton), and (d) un marketable yield. fed^{-1} (ton). Error bars represent the standard deviation of the mean.

*Means in each column, followed by the same alphabetical letter(s) in common, are not significantly different at $p \leq 0.05$.

Biochemical composition of head lettuce leaves.

Concerning the results of some chemical composition of head lettuce leaves shown in Table (2), The results showed a gradual significant increase in the content of combined lettuce leaves of vitamin C, dry matter %, total soluble solids content (TSS), and carbohydrates % accompanied by an increase in liquid vermicompost fertilizer concentrations from 2.5% to 20% LVC during the two growing seasons. While the application of chemical fertilizer treatment (100% NPK) recorded the highest values for all the above-mentioned traits without significant difference from the values of the same traits when applying the treatment of vermicompost at a concentration of 20% LVC during the two cultivation seasons, respectively. This indicates a significant improvement in the quality of lettuce plants when fertilizing with liquid vermicompost at a concentration of 20% LVC as an organic fertilizer that can be used in organic farming programs without affecting the quality of the lettuce crop. The previous results agreed with (Zhao *et al.,* 2010) when compared to pure mineral fertilizers and pure chick manure compost, the addition of vermicompost or vermicompost with organic-inorganic mixed fertilizers significantly improved the overall quality of cucumber, including the ratio of sugar to organic acid, vitamin C, and total soluble solids in the greenhouse. In a presentation of some of the findings from previous research into the effect of using vermicompost fertilizers on some vegetable crops, it was discovered that adding vermicompost to the cultivation soil had no effect on ascorbic acid content and that there were no significant differences in lettuce plants between any of the chemical fertilization treatments *(Papathanasiou, et. al. 2012).* On tomato and Chinese cabbage plants, Zaller (2007), Roberts, *et. al.* (2007), and Wang, *et al.* (2010) observed conflicting effects of vermicompost fertilizations on ascorbic acid levels, depending on genotype and environmental conditions. The results also agreed with regard to the increase in the levels of vitamin C, dry matter, total soluble solids, and carbohydrates with vermicompost fertilization treatments with Donohoe (2018) on some horticultural crops.

Table 2. Biochemical composition of head lettuce leaves affected by liquid vermicomposting concentrations% and recommended rate of NPK%, during the two cultivated seasons.

Treatments	Vitamin C. (mg/100g)		Dry matter of leaves (%)		Total soluble solid (%)		Carbohydrates (%)	
	S1	S2	S1	S2	S1	S2	S1	S2
1- 2.5% LVC	57.88 c	59.48 d	30.17 b	31.25 b	0.89 c	1.07 b	0.73 c	0.77 d
2- 5% LVC	82.18 b	81.28 c	31.89 ab	31.48 b	1.22 bc	1.37 b	1.15 b	1.23 c
3- 10% LVC	86.84 ab	85.16 b	32.95 a	33.75 ab	1.56 b	1.61 b	1.23 b	1.32 bc
4- 20% LVC	90.85 a	91.39 a	33.17 a	34.58 a	2.47 a	2.68 a	1.55 a	1.42 b
5- 100% NPK	90.80 a	90.95 a	31.64 ab	32.42 ab	2.42 a	2.61 a	1.50 a	1.58 a

- Means followed by the same letter are not significantly different ($p < 0.05$). f.w. fresh weight.

The results in Tables (3 & 4) shows the effect of different treatments on the chemical content of the combined head leaves of lettuce during the two cultivated seasons. The gradual increase in liquid vermicompost concentrations from 2.5% to 20% led to a significant increase in the leaves content of macro and micro-elements (N^+, P^+, K^+, Mg^{2+}, Ca^{2+} and Fe^{2+}), while the application of the chemical fertilizer treatment 100% NPK, gave the highest values for the proportions of macro-elements nitrogen (N^+), phosphorus (P^+) and potassium (K^+) listed in Table No.(3) during both seasons, but without significant difference compared to the application of 20% LVC except K^+ content in first season only. On the other hand, the results recorded in Table (4) showed that the highest content of the leaves of the micro-mineral elements calcium (Ca^{2+}), magnesium (Mg^{2+}) and iron (Fe^{2+}) resulted from the application of 20% LVC treatment compared to the rest of the treatments, but without a significant difference compared to the chemical fertilization treatment of 100% NPK in Mg^{2+} and Fe^{2+} only . It is possible that this result can be attributed to the high content of vermicompost of microelements, as shown in Table (1). These results be due to vermicomposting is the process of red wigglers worms microbially composting organic wastes to produce organic fertilizer with higher amounts of organic matter, organic carbon, total and available N, P, K, and micronutrients, as well as microbiological and enzyme activity (Edwards & Bohlen, 1996; Manivannan *et. al.*, 2009 and Parthasarathi *et. al.* 2008). According to Orozco *et. al.* (1996) and Donohoe (2018), vermicompost contains nutrients in forms that are easily absorbed by plants, such as nitrates, exchangeable phosphorus, and soluble potassium, calcium, and magnesium. According to Tomati *et. al.* (1990) and Parthasarathi *et. al.* (2008), vermicompost contains more humic acid and physiologically active substances such as plant growth regulators. Vermicompost contains highly enhanced nutrients, particularly nitrogen, which plants gradually absorb (Atiyeh *et. al.* 2000). Due to a reduction in electrical conductivity, vermicompost treatment in the soil promotes the retention of nitrogen and the progressive release of phosphorus, resulting in enhanced agricultural substrates (Lazcanoa & Dominguez, 2011). Total nitrogen sources, accessible phosphorus, magnesium, calcium, potassium, zinc, and other plant nutrients are present in vermicompost and are absorbed by all plant kinds (Belliturk, 2018).

Table 3. Macro-mineral composition of head lettuce leaves, as affected by liquid vermicomposting concentrations %, and recommended rate of NPK% fertilizer.

Treatments	Macro-minerals (% d.w.)					
	N^+		P^+		K^+	
	S1	S2	S1	S2	S1	S2
1- 2.5% LVC	0.72 d	0.72 d	0.27 c	0.26 c	1.01 d	1.07 c
2- 5% LVC	1.37 c	1.33 c	0.32 b	0.31 c	1.48 c	1.55 ab
3- 10% LVC	1.95 b	1.75 b	0.41 a	0.37 b	1.75 b	1.50 b
4- 20% LVC	2.33 a	2.38 a	0.42 a	0.39 ab	1.99 b	1.71 ab
5- 100% NPK	2.50 a	2. 37 a	0.45 a	0.45 a	2.26 a	1.77 a

- Means followed by the same letter are not significantly different ($p < 0.05$). f.w. fresh weight.

Table 4. Some micro-mineral composition of head lettuce leaves, as affected by liquid vermicomposting concentrations %, and recommended rate of NPK% fertilizer.

Treatments	Micro-minerals (% d.w.)					
	Ca^{2+}		Mg^{2+}		Fe^{2+}	
	S1	S2	S1	S2	S1	S2
1- 2.5% LVC	1.405 c	0.779 d	0.209 b	0.143 d	0.578 c	0.595 d
2- 5% LVC	1.416 c	1.238 c	0.279 a	0.217 c	0.821 b	0.812 c
3- 10% LVC	1.562 ab	1.328 bc	0.257 ab	0.246 bc	0.868 ab	0.852 b
4- 20% LVC	1.634 a	1.427 b	0.298 a	0.302 a	0.908 a	0.914 a
5- 100% NPK	1.453 bc	1.586 a	0.283 a	0.276 ab	0.906 a	0.909 a

- means followed by the same letter are not significantly different ($p < 0.05$). f.w. fresh weight.

Conclusion

From this study it is clear that using liquid vermicompost is promising in cultivation especially with lettuce compared with using chemical fertilization. In particular, vermicomposting is one of the main doors for recycling plant and animal organic waste to produce an organic fertilizer with a high content of the elements necessary for plant growth. Therefore, it can be recommended to completely replace the chemical fertilizer by using liquid vermicompost fertilizer at a concentration of 20% LVC without prejudice to the production of lettuce in quantity and quality.

References

AOAC, (2000). Association of Official Analytical Chemists.17th ED. of AOAC international Published by AOAC international Maryland, USA, 1250pp.

AOAC, (2016). Official Methods of Analysis of AOAC international. 20th ED. Published by AOAC international Maryland, USA, 3250pp.

Arancon, NQ., Edwards, CA., Bierman, P., Metzger, J.D., Lee, S. and Welch, C. (2003). Effects of vermicomposts on growth and marketable fruits of field-grown tomatoes, peppers and strawberries: the 7th international symposium on earthworm ecology. Cardiff. Wales. 2002. Pedobiologia 47, 731–735.

Atiyeh, RM, Arancon N, Edwards CA and Metzger JD (2000). Influence of earthworm-processed pig manure on the growth and yield of greenhouse tomatoes. Bioresource Technology 75: 175-180.

Belliturk, K (2018). Some evaluations about use of vermicompost in agricultural activity of thrace region, turkey: a review. rice research: Open Access, 06(03), 1–6.

Donohoe, K (2018). Chemical and microbial characteristics of vermicompost leachate and their effect on plant growth. Ph.D. Thesis, School of Life and Environmental Science The University of Sydney.

Edwards, CA and Bohlen PJ (1996). Biological and ecology of earth worms. Chapman and Hall, London pp.426.

Eker, M (2016). The research of effect to growth of different outdoor ornamental plants of vermicompost and other some organic fertilizers MSc. Thesis. Namık Kemal University, Graduate School of Natural and Applied Sci.

Ismail, AS (1997). Vermicology: the biology of earthworms. Orient Longman Ltd, Chennai, India 92p.

Kim, MJ, Moon Y, Kopsell DA, Park S, Tou JC and Waterland NL (2016 a). Nutritional value of crisphead 'iceberg' and romaine lettuces (*Lactuca sativa* L.). Journal of Agricultural Science, 8(11):1-10.

Kim, MJ, Moon Y, Kopsell DA, Park S, Tou JC and Waterland NL (2016 b). Nutritional value, bioactive compounds and health benefits of lettuce (*Lactuca sativa* L.). Journal of Food Composition and Analysis., 49:19-34.

Kim, S , Lim S, Seo Y, Cho B, Choi S, Hur S, Kim J and Kim I (2014). Chemical characteristics of earthworm vermicompost and its application effects on soil properties to produce organic vegetables. ELS2014 –The Earth Living Skin: Soil, Life and Climate Changes, EGU – SSS Conference.

Lazcanoa, C and Dominguez L (2011). The use of vermicompost in sustainable agriculture. Impact on Plant Growth and Soil Fertility136:22-71.

León, AP, Pérez Martín J and Chiesa A (2012). Vermicompost application and growth patterns of lettuce (*Lactuca sativa* L.). Agricultura Tropica et Subtropica, 45(3), 134–139.

Mackay, A., Syers, J., Springett, J. and Gregg, P. (1982). Plant availability of phosphorus in superphosphate and a phosphate rock as influenced by earthworms. Soil Biol. Biochem. 14, 281–287.

Manivannan, S, Balamurugan M, Parthasarathi K, Gunasekaran G and Ranganathan LS (2009). Effect of vermicompost on soil fertility and crop productivity-beans (Phaseolus vulgaris) J. Environ. Biol., 30(2): 275-281.

Orozco, FH, Cegarra J, Trujillo LM and Roig A (1996). Vermicomposting of coffee pulp using the earthworm Eisenia fetida: effects on C and N contents and the availability of nutrients. Biol. Fert. Soils 22: 162-166.

Page, A, Miller R and Keeny D (1982). Methods of soil analysis, Part 2: Chemical and Microbiological Properties. Amer. Soc. of Agro. Madison, WI., USA.

Papathanasiou, F, Papadopoulos I, Tsakiris I and Tamoutsidis E (2012). Vermicompost as a soil supplement to improve growth, yield and quality of lettuce (*Lactuca sativa* L.). Journal of Food, Agriculture and Environment, 10(2), 677–682.

Parthasarathi, K, Balamurugan M and Ranganathan, LS (2008). Influence of vermicompost on the physico-chemical and biological properties in different types of soil along with yield and quality of the pulse crop-blackgram. Iranian Journal of Environmental Health Science and Engineering, 5(1), 51–58.

Patil, SL and Sheelavantar MN (2000). Effect of moisture conservation practices, organic sources and nitrogen levels on yield, water use and root development of rabi sorghum (*Sorghum bicolor* L.) Moench in the vertisols of semiarid tropics. Annual Agriculture Research 21: 32-36.

Quaik, S., Hossain K., and Ibrahim MH (2016). "Vermicomposting Derived Liquids: Fertigation Potential in Urban Farming." International Journal of Agricultural Research 11: 135-142.

Roberts, P, Jonesand DL and Edwards-Jones G (2007). Yield and vitamin C content of tomatoes grown in vermicomposted wastes. J. Sci. Food Agric. 87: 1957-1963.

Singh. BK, Pathak KA, Verma AK, Verma VK and Deka BC (2011). Effects of vermicompost, fertilizer and mulch on plant growth, nodulation and pod yield of french bean (*Phaseolus vulgaris* L). Vegetable Crops Research Bulletin .74: 153-165.

Singh, RP. and Varshney G. (2013). Effects of carbofuran on availability of macronutrients and growth of tomato plants in natural soils and soils amended with inorganic fertilizers and vermicompost. Commun. Soil Sci. Plant Anal. 44, 2571–2586.

Sinha. RK, Agarwal S, Chauhan K and Valani D (2010). The wonders of earthworms & its vermicompost in farm production: Charles Darwin's 'friends of farmers', with potential to replace destructive chemical fertilizers. Agriculture Science 1: 76.

Steel, RG and Torrie JH (1980). Principles and Procedures of Statistics. McGraw-Hill, New York.

Tejada, M, Gonzalez J, Hernandez M and Garcia C (2008). Agricultural use of leachates obtained from two different vermicomposting processes. Bioresource Technology 99:6228-6232.

Tomati, U, Galli E, Grapppelli A and Dihena G (1990). Effect of earthworm casts on protein synthesis in radish (*Raphanus sativum*) and lettuce (*Lactuca sativa*) seedlings. Biol. Fert. Soil 9: 288-289.

Vadiraj, BA and Potty SS (1998). Response of coriander (*Coriandrum sativum L.*) cultivars to graded levels of vermicompost. Journal of Spices and Aromatic Crops 7 (2): 141-143.

Wang, D, Shi Q, Wang X, Wie M, Hu J, Liuand J and Yang F (2010). Influence of cow manure vermicompost on the growth, metabolic contents, and antioxidant activities of Chinese cabbage (*Brassica campestris ssp. chinensis*). Biol. Fertil. Soils 46:689-696.

Zaller, JG (2007). Vermicompost as a substitute for peat in potting media: Effects on germination, biomass allocation, yields and fruit quality of three tomato varieties. Sci. Hort. 112:191-199.

Zambare, VP, Padul MV, Yadav AA and Shete TB (2008).Vermiwash biochemical and microbiological approach as eco-friendly soil conditioner. Biol Sci 3 (4): 1-5.

Zhao, H., Luo J., Dan Y., Wang A., Liu P., and Feng K (2010). Effects of vermicompost organic-inorganic mixed fertilizer on yield and quality components of cucumber cultivated in greenhouse (in Chinese with English abstract). Plant Nutr. Fertil. Sci. 16, 1288–1293.

Assiut J. Agric. Sci., 52 (3) 2021 (69-81) *ISSN: 1110-0486*
Website:www.aun.edu.eg/faculty_agriculture/journals_issues_form.php *E-mail: ajas@aun.edu.eg*

تأثير سائل الفيرميكمبوست العضوي كبديل للأسمدة الكيماوية على الصفات المورفولوجية والبيوكيميائية في الخس

أميرة عبد الحميد هلالى[1] و رحاب عبد المعطى الدقاق[2]

[1]قسم الخضر، كلية الزراعة، جامعة الإسكندرية ، مصر.
[2]قسم النبات والميكروبيولوجى، كلية العلوم ، جامعة الإسكندرية ، مصر.

الملخص

يُعد إستخدام سائل الفيرميكمبوست العضوى من البدائل الواعدة للأسمدة الكيماوية، لذلك يهدف البحث إلى دراسة تأثير استخدام سماد الفيرميكمبوست السائل كبديل للأسمدة الكيماوية على إنتاج الخس الصنف كرسبى؛ فى هذه الدراسة اجريت التجربة الحقلية خلال موسمى شتاء عامى 2019 – 2020 و ٢٠٢٠ – 2021 بمحطة البحوث الزراعية بمنطقة أبيس التابعة لكلية الزراعة جامعة الإسكندرية. وقد هدفت الدراسة إلى تقييم مدي استجابة نباتات الخس الى استخدام سماد الفيرميكمبوست السائل باستخدام اربع تركيزات مختلفة وهى: 2.5٪ ، 5٪، 10٪، 20٪ بالإضافة إلى معاملة التسميد الكيماوى بالمعدل الموصى به لانتاج الخس (100٪ NPK) كمعاملة كنترول على بعض صفات النمو الخضري؛ وزن النبات الطازج (كجم)، الوزن الصافي لرأس النبات (كجم)، المحصول الكلى للفدان (طن)، والمحصول غير القابل للتسويق للفدان (طن)، بالإضافة إلى بعض الصفات البيوكيميائية وهي (فيتامين ج، المادة الجافة، المواد الصلبة الذائبة الكلية، والكربوهيدرات) وكذلك تقدير محتوى بعض العناصر مثل النيتروجين (N^{+}) والبوتاسيوم (K^{+}) والفوسفور (P^{+}) والكالسيوم (Ca^{2+}) والمغنيسيوم (Mg^{2+}) والحديد (Fe^{2+}). وقد اوضحت النتائج وجود زيادة تدريجية فى قيم معظم الصفات المدروسة بزيادة تركيزات سماد الفيرميكمبوست من 2.5٪ الى 20٪، فى حين أن تطبيق معاملة الفيرميكمبوست بتركيز 20٪ أعطت أعلى القيم المعنوية لأغلب الصفات المدروسة دون فرق معنوى واضح مقارنة بمعاملة التسميد الكيماوى 100٪ NPK. من هنا يمكن التوصية بأستبدال التسميد الكيمياوى كلياً بأستخدام سماد الفيرميكمبوست السائل بتركيز ٢٠٪ دون الإخلال بإنتاج الخس كما ونوعا.