Asian Soil Research Journal

2(1): 1-10, 2019; Article no.ASRJ.42411

Effect of Earthworm on Lettuce Production through the Recycling of Organic and Bio-Compost Production

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

Article Information

Editor(s):
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Complete Peer review History: http://www.sdiarticle3.com/review-history/42411

Data Article

Received 05 May 2018
Accepted 24 July 2018
Published 22 March 2019

ABSTRACT

Lettuce is one of the most abundant leafy vegetables and is consumed in its raw form by humans, all over the world. This study is conducted in one of the fields in the district of Al-Garmah City, Iraq, to investigate the effects of several fertilizers (Animal, Chemical, and Compost fertilizer). The crop of lettuce harvested from Aug 2017 to Mar 2018, was used in this study. The experiment is carried out in two stages. The first stage includes the multiplication of the earthworm and the production of the worm (vermicompost). The second stage includes the cultivation of lettuce in three replicates with ten coefficients and additions of animal fertilizer, vermicompost and chemical fertilizer (N, P, and K). The results show that the highest productivity is shown in the lettuce plant in vermicompost second with level recommendation half of the fertilizing, and second-ranked vermicompost and chemical. Only the second level and the third place in the recommendation vermicompost 1/2 second with level waste sheep 1/2 second level. The result showed the percentages of the treatment (T5), (T8),

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(T3), (T9), (T7), (T2), (T1). It is concluded that the production of vermicomposts in a specialized farm which is environmentally-friendly and hygienic, results in more healthy crops for the consumer, which should be given into consideration. More research in this area is needed to fully understand the ecology of different earthworm species, their interactions and their potential roles in promoting the more sustainable farming system.

Keywords: Earthworms; vermicomposts; organic fertilizer.

1. INTRODUCTION

In recent years, changes in lifestyle and eating habits have led to growth and popularity of fresh vegetables. The current high demand for fresh vegetables is the result of consumers' desire to obtain healthy, comfortable, new and ready to eat items. Among the different production methods, 'lettuce' form is a growth in the viability of processed vegetable products to a minimum. These are all shown as whole leaves, 8-12 cm in length, with only one very small section exposed to oxidation, thus increasing life after harvest, where consumers desire soft leaves in the center of lettuce (Gonzalez et al., 2004). Vegetables are the largest dietary source of nitrates; lettuce is one of the leafy vegetables that accumulate the most nitrates in it [1]. The amount of nitrate accumulation depends on genetic and environmental factors and agricultural techniques used [2]. It is known that the floating system can be used to produce vegetables with a low level of nitrate using different cultivation techniques, but it is also interesting to know whether it can be used to induce doses of N in nutrient solution without affecting plant growth. In this way, the final product would be a similar yield, but with less nitrate content. The clean farming system has been re-introduced in recent years after people are more aware of the damage and harm caused by the misuse of chemical fertilizers and pesticides on the environment, public health and food safety for human consumption. Many diseases related to kidney and liver, as well as other serious diseases have emerged. On the development of new agricultural strategies and environmentally-friendly technologies, one of the most important features is clean agriculture technology, which is represented by organic and bio-agriculture and based on organic fertilizers, bio-fertilizers and biological pest control. As the cost of chemical fertilizers increases, it will reduce the farmers' profits. In addition, chemical fertilizers cause damage to both consumers' health and the environment. Therefore, it is necessary to explore and suggest the best ways to produce healthy and eco-friendly fertilizers. It is also necessary to find the most ideal and low-cost methods to increase crops production in order to increase the farmers' income and national income in general [3]; Patten and Glick 1996). Meanwhile, a study by [4], which focuses on the effective role of earthworms that will increase the production of the crop at the lowest seasonal cost. Anna, [5] states that compost fertilizer is healthy and environmentally-safe. The study encourages farmers to use compost fertilizer in order to increase the production of their crops, as it reduces the production cost, thus increase their income. Anna, [5] states that the methods of multiplication and propagation of earthworm are simple and earthworms can be multiplied in agricultural fields significantly by providing appropriate foods that encourage them to reproduce through the provision of the appropriate atmosphere for its reproduction.

1.1 Objectives of the Study

This study is important as it is the first study on the evaluation and multiplication of earthworms in Iraq. It also indicates its importance to earth and to increase productivity. The objectives of the study include the following:

1) To identify the method of earthworms multiplication in the agricultural field.
2) To identify the effects of earthworms on changing soil properties and their permeability.
3) To identify the effects of earthworms' residues (vermicomposts) on the production of lettuce.
4) To identify the best ways to produce beneficial organic matter in soil and plant.
5) To recommend an appropriate compost fertilizer that increases the production of lettuce.

2. MATERIALS AND METHODS

The data are analyzed for all studied properties according to the RCBD analysis using Least Significant Difference (LSD) test at a probability level of 0.5 (Torrie and Steel, 1960). The land for the study is chosen in the district of Karma, a land situated close to the judicial center with the area of 2500 square meters. The land was ploughed, treated and designed in a suitable manner. Three replicates for each design were built to establish the comparison between the use of chemical fertilizer, animal manure and worm's residue (vermicomposts).

Earthworm breeding and production vermicomposts [6] confirmed that the use of the liquid of vermicomposts fertilizer at a concentration of 2 ml / liter of strawberry leaves increased the paper area by 18.9% and the dry matter of the plant by 27% and reduced the fruit deformation by 8.9% and the gray mold by 5.1% Resulted in an 18% increase in productivity and a 30% improvement in the quality of marketable productivity. Five wooden boxes were prepared for this purpose with dimensions of 100 x 80 x 40 cm, perforated from the bottom for drainage of water and excess fluids and also perforated from the sides in the upper third of the ventilation. Their floor was sprayed in equal quantities for some organic mixed wastes represented by scraps of paper, newspaper, and wheat straw, which was soaked with water in advance and then squeezed and sprayed the ground with a height of 20 cm in order to be a source of worms and to maintain moisture and ventilation suitable for them. Then add to each box 5 kg of mixed soil mixed with pitmus with 2 soil: 1 ptosis (2.5 kg per 5 kg soil) and mixed with the previous bedding, then wet the previous layer with appropriate moisture as the worms prefer wet medium but not to the extent that And each period add a little water sprinkle on the surface evenly on the five boxes whenever observed near the dryness of the center to maintain appropriate moisture for the worms. Worms were added to this medium with 200 gr dud per box (approximately 100 worms per box).

We began by adding the kitchen waste on the middle surface from the first day to put the worms in the box and equally (the quantity and quantity) on the five boxes to feed the worms during the period of their growth. According to research, the worms consume about half of their weight to the equivalent of their weight per day depending on environmental conditions. The main additions were fruits and vegetables, some garden residues, tea leaves, and dried egg shells. These were added to the residue. As well as the residues and peels of citrus. The addition of high-fat or citrus materials leads to the staining of the environment, the emission of unpleasant odours, as well as the growth of microorganisms. Unwanted. The worms were left to grow and multiply for approximately three months (until 8/10/2017). To analyze the material and the added residues, after the period of the medium, it gradually turns into brownish residue, although there are non-decomposed food residues that may be the last additions or old residues. Worms which are excluded at the end of this stage. Samples of the randomly generated vermicomposts were taken from the five boxes and mixed together for analysis. Experimental parameters were shown in Table 1 for experiment coefficients.

Table 1. Experiment coefficients

Items	Additions	Type of transaction
T1	Without additions	Comparative treatment (soil only)
T2	120kg dab / dunam	Chemical fertilization (full celestial recommendation of lettuce plant)
T3	Vermicompost 2 tons / dunam	Vermicompost only the first level
T4	Vermicompost 4 tons / dunam	Vermicompost only the second level
T5	Vermicompost 2 tons + 60 kg dap / dunam	Vermicompost first + level recommendation half of the fertilizing
T6	Vermicompost 4 tons + 60 kg Dab / dunam	Vermicompost second + level recommendation half of the fertilizing
T7	Waste sheep 2 tons / dunam	Animal fertilizer (waste sheep first level)
T8	Waste sheep 4 tons / dunam	Animal fertilizer (second level sheep waste)
T9	Vermicompost 1 ton / dunam + waste sheep 1 ton / dunam	Vermicompost 1/2 first + level waste sheep 1/2 first level
T10	Vermicompost 2 tons / dunam + waste sheep 2 tons / dunam	Vermicompost 1/2 second + level waste sheep 1/2 second level

Dunam=2500m

3. RESULTS AND DISCUSSION

3.1 Effect of Transactions Used on Some Morphological Characteristics and Leaf Lettuce

Table 2 shows the result that indicates the significant differences in the coefficients of all head height ratio of lettuce plants growing in different fertilizers. T6 has the highest increment rate, with a rate of 36 cm, followed by T4 (35 cm), T10 (34 cm). The increment rate for T5, T3, T8 and T9 are 33 cm, 32 cm, 32 cm, 32 cm and 31 cm, respectively. The lowest rate is 30 cm, which is the first treatment, where the rate of increment is lower than the rest of the transactions.

The results in Table 2 show that the highest weight of the head of lettuce is in the sixth treatment (T6), which is 1280 g. This is due to the fact that organic matter contains the necessary elements for the growth of lettuce, hence giving it an ideal growth. In term of the weight of the head, all treatments are significantly higher. The second highest weight is T4, followed by T10 (1210 g). The weight of T5, T8, T3, T9, T7, and T2 are 1192 g, 1164 g, 1120 g, 1025 g, 975 g and 925 g, respectively. The lowest weight is recorded in the first treatment (T1). The average weight is 1235 g.

As for the edible leaves, the results in Table 2 show that there is a significant superiority in the number of edible leaves for the comparison treatment T1, where there are 27 edible leaves with a total estimated 71.0%. The percentage of palatable and edible leaves range from 42 to 2. The ratio of the number of edible leaves to the proportion of T1 recorded the highest in T4, followed by T10 and T5, where each treatment is registered with 64, 62 and 57 edible leaves, with the percentage of 90%, 88% and 86%, respectively. T3, T8, T9, T7 and T2 produce 51, 49, 46 and 42 edible leaves, or 83%, 82%, 82% and 82% respectively.

The low productivity of T1 is due to the condition of the soil, which is poor in the nutrients necessary for the growth of lettuce, as well as high gypsum soil, as demonstrated during soil analysis before planting. Therefore, it is necessary to add the essential elements needed by the plant to grow well and ideally. This refers to the study of (Basim, 2016), noting that lettuce needs the necessary elements of growth to increase its productivity and cannot be cultivated in poor soil. These results are consistent with [7] that the addition of vermicompost to lettuce improved the quality of the lettuce plant. It led to an increase in soft weight, head size, number of leaves, leaf length, leaf width and dry weight of the plant. With the increase of the level of vermicompost, there is an increase in some essential elements in plants such as nitrogen, phosphorus, potassium, magnesium, and calcium, though this increment is not significant. This study determines the effect of vermicompost on plant growth in a positive and significant production and compares the increment of the total number of lettuce with different fertilizers. This is the first study of its kind conducted in Iraq.

3.2 Effect of the Coefficients Used on the Rate of Some Physiological Characteristics of the Lettuce Plant

Despite the great development in the laboratory equipment around the production of the plant, this method is still one of the most significant methods to diagnose the lack of nutrients in the plant. Each element has a certain effect or a set of effects on each plant, hence, the absence or lack of certain elements equal to the critical limit of lack of soil or interference from other elements. Therefore, this study focuses on the three major elements i.e. nitrogen, phosphorus, and potassium (N, P and K). The results in Table 3 show that there is a significant increment in all experimental treatments from different fertilizer. Chlorophyll ranged from 0.47 mg^{-1} (T2) to 0.57 mg^{-1} (T6) for vermicompost fertilizer with high-dosage of chemical fertilizers and half.

It is also shown in the results that there is a positive correlation between the treatments and the treatment of the soil without any fertilizer to the treatment T1, which records a rate of 0.41 mg^{-1}. The rate for T2, T7, T3, T8, T9, T5, and T10 are 0.47 mg^{-1}, 0.49 mg^{-1}, 0.51 mg-1, 0.52 mg^{-1}, 0.52 mg^{-1}, 0.53-0.52 mg^{-1} and mg^{-1}.5, respectively.

The results in Table 3 show that the percentage of edible fat concentration is ranged between 1.95% (T1) to 3.21% (T6). The percentage of T4, T10, and T5 are 2.84%, 2.68% and 2.59%, respectively. Meanwhile, the percentage of T7, T9, T3, T8 are 2.15%, 2.20%, 2.29%, and 2.35% respectively. The first comparison treatment recorded soil without any additional fertilizer with the lowest percentage of fat concentration, which is 1.53%. The highest concentration of nitrogen in lettuce is found to be 2.27% (T6), which is significantly higher than T1 (1.28%). All fertilizer transactions achieve a significant increase in the ratio of nitrogen in lettuce leaves in comparison to leaves without any additional fertilizer. The nitrogen concentration ranged between 1.54% (T2) to 2.27% (T6).

As for the phosphorus component found in the lettuce leaves, the results show that all the study coefficients are significantly higher. T6 shows the highest concentration of phosphorus (0.71%) followed by T4 (0.68%) and T10. While the comparison treatment T1 is recorded for the recommendation without any additives with the lowest concentration of phosphorus and its value is 0.32%, where there is a huge difference between the comparison treatment without additional fertilizer and the rest of the treatments with different fertilizer. The treatment is recorded by recommending the chemical fertilizer at the last penultimate level i.e. after the treatment of the comparison and recorded a concentration of phosphorus of 0.46%. Meanwhile, the phosphorus concentration of T7, T9, T3, T8, T5, and T10 are 0.49%, 0.50%, 0.51%, 0.58%, 0.60%, 0.60% and 0.68, respectively.

The results in Table 3 show that the concentration of potassium is recorded the highest in T6 (3.83%), followed by T4 (3.22%), T10 (3.19%), and T5 (3.16%). Meanwhile, the concentration of potassium in T8, T9, T3, and T7 are 2.91%, 2.81%, 2.35% and 2.15%, respectively. In a research on the effect of vermicompost on growth (Rakes Joshi and Pal Vig, 2010), harvest and quality of tomatoes in 15%, 30% and 45% vermicompost of soil weight shows a significant increase in germination rate of seeds, increase in diameter and length of the plant, and increase in the percentage of addition. It is also observed that there is a significant increase in the biomass in the soil as well as improving the quality of the share with increasing of the percentage of addition of vermicompost. In [8] the addition of 30% of vermicompost to the soil resulted in a significant increase in stem diameter, length of the plant, number of leaves and flowers in comparison with control treatment, where vermicompost is not added. P, K, Ca and Mg reduce soil pH from 6.8 to 6.6, as well as the activation of microorganisms and increase the biomass in soil.

Table 2. Effect of the treatments used on leaves of lettuce in the physiological rate

Treatment	Head height (cm)	Percentage of edible leaves %	Many edible leaves	Number of leaves	The weight of head (g)
T1	26	71.0	27	38	530
T2	30	77.0	42	54	925
T3	32	83.0	51	61	1120
T4	35	90.0	64	71	1235
T5	33	86.0	57	66	1192
T6	36	90.0	66	73	1280
T7	31	82.0	46	56	975
T8	32	85.0	55	64	1164
T9	32	84.0	49	58	1025
T10	34	88.0	62	70	1210
LSD. 0.05	2.453	3.204	3.780	8.813	117.9

Table 3. Transactions effect used in the physiological rate of lettuce leaves

Treatment	%K	%P	%N	% Fat	Chlorophyll mg g^{-1}
T1	1.55	0.32	1.28	1.53	0.41
T2	2.10	0.46	1.54	1.95	0.47
T3	2.35	0.51	1.82	2.29	0.51
T4	3.22	0.68	2.10	2.84	0.55
T5	3.16	0.60	1.95	2.59	0.53
T6	3.83	0.71	2.27	3.21	0.57
T7	2.15	0.49	1.67	2.15	0.49
T8	2.91	0.58	1.75	2.35	0.52
T9	2.82	0.50	1.71	2.20	0.52
T10	3.19	0.66	2.00	2.68	0.54
LSD. 0.05	0.354	0.120	0.278	0.295	0.019

The results of Table 3 showed that the concentration of potassium was highest in T6 and recorded a concentration of 3.83%, followed by T4, T10, and T5 respectively. The total concentration of potassium was 3.22%, 3.19% and 3.16%, which represents the fertilizer recommendations of Vermicomposts and animal manure. While the following treatments came in the second phase with potassium concentration in lettuce leaves. The T8, T9, T3, and T7 were exchanged with successive values of 2.91%, 2.81%, 2.35% and 2.15%. In a research done by researchers (Rakes Joshi and Pal Vig, 2010) on the effect of vermicomposts on the growth, yield and quality of tomatoes in 15%, 30% and 45% Vermicomposts of soil weight, which showed a significant increase in germination rate of seeds and increase in diameter And the length of the plant and the increase in the percentage of addition, also observed a significant increase in the biomass in the soil as well as improved qualities of the quality of the share with increasing the percentage of addition of vermicomposts. In the study of [8], the addition of 30% of vermicomposts to the soil resulted in a significant increase in stem diameter, length of the plant, a number of leaves and flowers compared with control treatment not added to vermicomposts. P, K, Ca and Mg, also reduced soil pH from 6.8 to 6.6. As well as the activation of microorganisms and increase the biomass in the soil.

3.3 Effect of the Coefficients Used in Leaf Contains Cd, Cu, Mn, Zn, Fe

The results in Table 4 show that there is a significant difference of iron in soil samples used after the agriculture. It shows that the highest (188.6, 192.1 and 183.2 mg/kg $^{-1}$) Fe is found in T4, T6 and T10 (81.4 mg^{-1}). This indicates that there is a significant increment of Fe concentration in the soil. The lowest concentration recorded is 128.3 mg/kg^{-1}, where chemical additives are used in the treatment. The concentration of Fe in T3, T5, T7, T8 and T9 are 156.4, 163.9, 148.2, 177.1, and 150.3 mg kg $^{-1}$, respectively.

In addition, the result in Table 4 shows that the fertilizer parameters are used to increase the concentration of Zn, Mn, Cd, and Cu in the soil for the post-cultivation treatments. The highest mean concentration of Zn concentration ranged between 48.2 to 68.0 mg/kg $^{-1}$. Meanwhile, the Mn ratio for the comparative treatment/soil is 40.5. The result in Table 4 shows that the highest mean of Mn concentration for T4 and T6 are 79.1 mg / kg^{-1} and 82.1 mg / kg^{-1}, respectively, in vermicompost fertilizer with chemical fertilizer additives. As for other fertilizer treatments, there is an increase in Mn component of the soil after planting. For Cd component, the result shows that there is an increase in Cd component after planting in soil with endometrial additives. The highest concentration of Cd is in T5 (0.71 mg kg $^{-1}$) and T6 (0.74 mg kg^{-1}). On the treatment of soil comparison without any addition, the concentration of Cd is 0.62 mg kg $^{-1}$.

As for Cu component, the result shows that there is a significant effect on the treatment of soil without fertilizer additions in comparison to other fertilizers. The concentration of Cu for the fertilizers and chemical fertilizers ranged from 9.9 mg / kg^{-1} to 13.9 mg / kg^{-1}. The concentration of Cu is 7.4 mg/kg $^{-1}$ for soil treatment without any fertilizer recommendations.

Plant analysis should not rely on the diagnose of the lack of micro-elements needed by the plant alone, especially on minor elements. This is because the critical limit of each plant element is still not fully known. The form in which the element is found in the plant and the ratio of each element to the nucleus is still unclear. The quantity of an element may be seen in infected leaves larger than those found in healthy leaves. In addition, the plant requirements of any of these elements may vary from plant to plant and from time to time plant during the period of its life.

The increase of nutrient availability in the soil comes from the containment of compost, as well as the addition of the soil-added vermicompost to a good proportion of the elements of iron, zinc, manganese, and copper, which can be extracted. In addition, the organic acids resulting from the decomposition of organic matter and the vermicompost produced from the fungus and decomposed into the materials absorbed by the plant also play some roles. These acids compete on the surface of adsorption because they contain effective aggregates that reduce the reaction of these elements with the decomposition surfaces (Kumar, 2010). Apart from that, CO_2 resulting from the decomposition of organic matter plays the role of carbonic acid that reduces the pH value of the soil and becomes one of the most important factors in the process of adsorption, sedimentation, and reduction of phosphorus rock (Rosen and Bierman, 2007).

The results also show that the increase in iron concentration in the fertilized soil from the fertilizers and organic fertilizers is consistent with the increase in the density of microorganism solubility of phosphate compounds with organic fertilizers used, which have the ability to release certain substances and compounds such as siderophore. These compounds help to increase the concentration of iron and other small elements such as zinc, cadmium, and copper in the soil. It is shown that the most important role of organic fertilizer and vermicompost is to increase the readiness of zinc element in the soil by providing ready-made zinc and its preservative role in the preservation of the transformation to the non-soil formulation [9].

In addition, the results show that organic fertilizers and vermicompost are an important source of micro-nutrients and nutrients in the soil due to their association with organic matter. The concentration of nutrients remains in the soil at the harvest stage is high, indicating the importance of using organic fertilizer and vermicompost. It also indicates the role of the actor in raising nutrient limits in the soil for subsequent crops in order to ensure an important part of plant requirements for nutrient needs and balance these nutrients in the soil. The study shows an increasing concentration of iron, zinc, cadmium, manganese, and copper extracted by higher DTPA, which is due to the usage of vermicompost.

These results are consistent with the findings in [10]; soil fertilization reduces the effective effect of some types of heavy metals due to vital activities of the living areas and the formation of claws, which turns the contaminated soil into an environment free of heavy metal activity. According to Angelova et al., [10], the addition of fermented organic matter for a long time changes the ratio of humic acid to the benefit of the acidic humic at the expense of the Volvik, which is active by increasing the release of heavy elements. This can be observed in organic fertilizers prepared locally by increasing the acidic humic in the components of organic substances produced by decomposition [11]. These results shall encourage farmers to adopt the use of vermicompost in order to produce chemical-free vegetables at low-cost. The effect of the transactions used in the content of Cd, Cu, Mn, Zn, Fe signal results Table 4 that highest rate and 184.3 185.2 and 186.1 mg kg^{-1} (of iron found in T9 and T10 transaction papers and T8 respectively, as moral beat iron concentration rate 163.5 and 174.2 mg kg^{-1} in leaves of treated soil Without adding the soil by adding compost DAB sequentially.

3.4 Effect of the Treatments Used in Some Soil Properties and Content of N, P, K after Planting

Table 5 shows that there is a significant effect on the reduction of pH value of the soil after cultivation by the fertilizers used, i.e organic fertilizer, vermicompost, and chemical fertilizer by recycling organic solid waste. The pH value is lower than 7.53 (T2), which is the highest pH until T5, T9, which was the lowest pH 7.50. On the other hand, it is interesting to note that there is an increase in all treatments used in the electrical conductivity of the soil after planting. The electrical conductivity of soil value is the highest for T6, which is 2.60 deciSiemens M^{-1} and it is significantly higher than other treatments.

Table 5 also shows that there is a significant difference in the soil organic matter rate after planting. The percentage of organic matter of T6 increases by 0.97%, before it reaches 0.99%, until it reaches the highest ratio, 2.94%. The percentage of soil organic matter rate of T4, T8, and T10 are 2.87%, 2.15%, and 2.69%, respectively. Table 5 shows that there is a significant difference in the total of nitrogen ratio of the soil after planting for all treatments. The lowest total nitrogen level recorded is 110.4 mg/kg^{-1} (T2), representing the treatment in which only chemical fertilizer is used. The total nitrogen level of T3, T7, and T9 are 135.7, 127.5 and 130.4 mg kg^{-1} respectively. Meanwhile, T4, T5, T8, and T10 recorded high value of the total of nitrogen level, with the value of 158.5, 147.6, 140.8 and 151.2 mg^{-1}, respectively. The highest value is recorded in T6, which is 173.8 mg^{-1}.

The results in Table 5 depict an increase in the ratio of organic matter (OM) in all fertilizer coefficients. The results show that the highest percentage of increment in organic matter is recorded in T6 (2.94%), followed by T4 (2.87%), and T10 (2.69%). Meanwhile, the percentage of OM in T8, T5, and T3 are 2.15%, 1.95% 1.97% and 1.95%, respectively. T7, T8, and T2 show the percentage of OM of 1.78%, 1.66%, and 0.99%, respectively. The first treatment of soil without any additional fertilizer has the percentage of 0.97%. As for electrical conductivity (EC), the coefficients are significantly higher and the electrical conductivity of other coefficients is higher than T1 in comparison. The lowest value of EC is recorded in T1, which is ds m-1 2.42, while the highest value is recorded in T6, which is ds m-12.60. The second highest EC value is recorded in T10 (ds m^{-1}2.58), followed by both T4 and T8 (ds m^{-1} 2.57). The EC value for T7, T5, T9 and T3 are ds m^{-1} 2.55, ds m^{-1} 2.53, ds m^{-1} 2.51, ds m^{-1} 2.50 and ds m^{-1} 2.4, respectively.

Table 5 depicts the result on CEC. It shows that there is a significant difference for all fertilizer treatments. The highest value is recorded in T6 (Cmole Kg^{-1} 44.9), followed by T10 (Cmole Kg^{-1}44.5), T4 (Cmole Kg^{-1} 42.6) and T8 (Cmole Kg^{-1}40.1). T5 is ranked fifth with the value of Cmole Kg^{-1} 36.7. T3, T9, T7 and T2 ranked next with Cmole Kg^{-1} 35.9, Cmole Kg^{-1} 35.2, Cmole Kg^{-1} 33.4 and Cmole Kg^{-1} 17.3, respectively. Table 5 also shows that there is a significant difference of phosphorus-ready level for the treatments used for soil after agriculture by recycling organic matter in the soil. Ranging between 12.4 mg / kg^{-1} (T2) to 24.5 mg / kg^{-1} (T6), it surpasses the phosphorus level remaining in the treatment of comparative soil, 10.6 mg kg^{-1}, and locally grown fertilizers contributed a good 13.7% of phosphorus-ready level and remaining in the soil after planting for T6 reaches 173.8 mg kg $^{-1}$.

Furthermore, there is a significant effect of organic fertilizers on soil potassium uptake. The top highest concentration of potassium in soil after planting is 102.7 mg / kg^{-1} (T2), 142.7 mg / kg^{-1} (T7) and 148.1 mg / kg^{-1} (T9). The lowest concentration of potassium in the treatment of soil with chemical fertilizer is recorded in T2, while the highest concentration of potassium for soil after the cultivation is recorded in T6, which is 183.8 mg kg $^{-1}$. All cases are significantly higher than the percentage of potassium-ready soil after agriculture. There are several previous studies that indicate vermicompost as a chemical and biological enrichment in relation to manure [12,13].

Table 4. Effect of the transactions used in the content of the leaves of some 50 smaller elements (mg kg^{-1})

Treatment	Cu	Cd	Mn	Zn	Fe
T1	7.4	0.62	57.4	40.5	110.7
T2	9.9	0.65	64.2	48.2	128.3
T3	10.6	0.64	71.5	56.1	156.4
T4	13.5	0.69	79.1	64.0	188.6
T5	11.1	0.71	73.2	59.1	163.9
T6	13.9	0.74	82.1	68.4	192.1
T7	10.2	0.69	68.4	52.1	148.2
T8	12.3	0.68	70.2	54.2	177.1
T9	12.0	0.66	69.6	54.1	150.3
T10	13.3	0.70	76.3	60.1	183.2
LSD. 0.05	4.751	0.228	10.33	9.26	19.65

Table 5. Effect transactions on soil properties and content items after agriculture

Treatment	Understudy K $mgkg^{-1}$	Understudy P $mgkg^{-1}$	Understudy N $mgkg^{-1}$	O.M %	CEC Cmole Kg^{-1}	EC ds m^{-1}	PH
T1	105.4	10.6	91.3	0.97	16.8	2.42	7.54
T2	102.7	12.4	110.4	0.99	17.3	2.47	7.53
T3	150.5	15.2	135.7	1.95	35.9	2.50	7.52
T4	178.9	21.7	158.5	2.87	42.6	2.57	7.51
T5	151.4	18.3	147.6	1.97	36.7	2.53	7.50
T6	183.8	24.5	173.8	2.94	44.9	2.60	7.48
T7	142.7	14.1	127.5	1.66	33.4	2.55	7.51
T8	163.2	19.5	140.8	2.15	40.1	2.57	7.49
T9	148.1	15.0	130.4	1.78	35.2	2.51	7.50
T10	170.5	20.9	151.2	2.69	44.5	2.58	7.48
LSD. 0.05	13.21	2.269	9.82	0.132	4.807	0.127	0.840

In addition, the pH value of vermicompost used seems to exert a strong influence on the availability of these nutrients [14]. The results of the study show that the use of organic fertilizer, as well as vermicompost, had a significant effect on soil and biological properties, which included the percentage of organic matter, total nitrogen content, phosphorus readiness, and potassium compared with soil control. This organic effect of adding organic fertilizers and vermicompost from the recycled solid organic matter is due to the fact that this fertilizer contains a density of vitality and its effectiveness in the release of these nutrients from the sources of non - soluble or ready for these elements in the compost and soil components, as well as the containment of these organic substances and fertilizers of the nutrients [15]. The presence of humic organic acids in the organic fertilizer components and vermicompost fertilizer makes the condition suitable for the nitrogen soluble phosphorus solvents to work and contributes to the reduction of pH value and activation of the processes or the secretion of organic phosphorus enzymes with organic matter decomposition [16]. In addition, it helps the soil to decompose organic matter after cultivation.

Similarly, the phenomenon of variation in microbiology is related to the availability of organic matter and the vermicompost from the sources of carbon and the energy it needs in its growth that increases its effectiveness. This may be attributed to the competition that can be obtained from food and window, through the optimal use of specific factors in the environment affected by organic fertilizers [17,18]. This may be due to the increase in the concentration of the potassium element to the release of H+ ion from the dissolution of organic acids, the processes of mineralization of nitrogen and the formation of ammonium, which increases the process of potassium release to soil solution and soil exchange surfaces, as well as the organic fertilizer content, the ferment potassium, organic fertilizer in the solubility of certain compounds and minerals bearing potassium by organic acids [19].

Mahmoud, et al. [20] it is shown that the addition of vermicompost to the soil improves the physical properties of the soil, which includes the apparent density, building, porosity of the soil and its ability to retain water. It also improves vegetative growth and productivity. Sridharan and Hoone [21] suggested that the addition of vermicompost to the soil improves its physical properties, such as its ability to retain water, increase soil temperature during winter and reduce the soil pH value. The study also shows an improvement in soil fertility properties of nitrogen, phosphorus, and potassium.

4. CONCLUSIONS AND RECOMMENDATIONS

The results of this study show that in general, the nutrient in vermicomposts helps in the improvement of food production, without using chemical or organic nutrients.

The macronutrients such as N, P and K did not show a better rate. The stock content of magnesium, iron, zinc, and copper have lower concentration with vermicomposts, which can be an advantage on traditional compost. More studies are needed to assess the impact of periodic inputs and distinctive fertilization rates based on availability and nutrient content of organic fertilizers, as well as the impact of integrating organic fertilizers in the soil in a medium and long-term.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
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