The effect of vermicompost application on the growth of lettuce plant (*Lactuca sativa* L.)

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**Abstract.** The application of salt fertilizer to increase the productivity of lettuce in long term application will decline soil fertility. Implementation of totally organic farming in some region cannot increase productivity rapidly. The application of vermicompost combined with inorganic fertilizer is a solution to overcome decline lettuce production on the first time implementation of the organic farming system. This research aims to study the dose application of vermicompost on the growth of lettuce plant. The research conducted at Cisurupan-Garut West Java Province with altitude 1183 m above sea level from January to March 2018. The method used in this research is randomize block design with seven treatments (A= without vermicompost, B= 5, C=10, D=15, E= 20, F=25, G= 30 t ha⁻¹), and four replication. The growth parameter observed in this research was plant height, number of leaves, fresh plant weight, plant dry weight, and shoot-root ratio. The data observation parameter than analysed with variance analyse at five per cent signification level. The result of this research shows that the application of 5 t ha⁻¹ vermicompost improves plant growth significantly.

1. Introduction

The application of inorganic fertilizer to increase the productivity of lettuce in long term application will decline soil fertility [1]. Implementation of totally organic farming in some region cannot increase productivity rapidly. Application of vermicompost combine with inorganic fertilizer is a solution to answer decline lettuce production on the first time implementation of totally organic farming [2]. The application of different organic fertilizers will affect the soil zero point charge (pHo-pH H₂O) if the soil colloid is negative so that the soil colloid can bind the cations [3].

Characteristics of organic fertilizers is slow release cannot meet the nutrient requirements of plants at the beginning of plant growth so that if the plant's nutrient needs cannot be fulfilled, it causes growth retardation [4,5]. The combination dose between organic fertilizer and inorganic fertilizer in an area will differ depending on the characteristics of the soil and previous land use. The combination of an application of organic and inorganic fertilizers not only increases growth and yields but also can increase the efficiency of the use of organic and inorganic fertilizers to reduce production costs per unit area of land [6].

This study aimed to find out the effect of various vermicompost doses on the growth of lettuce plants to obtain the best dosage as a recommendation for vermicompost fertilization.
2. Methods
This research was conducted from January to March 2018 at Kecamatan Cisurupan, Kabupaten. Garut, Province of West Java with an altitude of 1183 m above sea level and has a type B climate (Wet) according to the Schmidt-Ferguson classification.

The materials used in this study were new Grand Rapid varieties of lettuce and vermicompost organic fertilizer. The tools used in this study include analytic scales, thermohygrometers, hoses, sacks, emitters, knives, ruler, threads, plastics, ruler, plastic cups, pH indicators, newsprint, staples, electric ovens, cellphone cameras, stationery, and notebooks.

The research method used was an experimental method with the design used was Randomized Block Design (RBD) consisting of 7 treatments K₀ = controls (without vermicompost organic fertilizer); K₁ = organic fertilizer dosage vermicompost 5 t ha⁻¹; K₂ = organic fertilizer dosage vermicompost 10 t ha⁻¹; K₃ = organic fertilizer dosage vermicompost 15 t ha⁻¹; K₄ = dose of organic fertilizer vermicompost 20 t ha⁻¹; K₅ = organic fertilizer dosage vermicompost 25 t ha⁻¹; and K₆ = the dose of organic fertilizer vermicompost 30 t ha⁻¹.

The observed parameters in this study consisted of two, namely the secondary observations and the main observations. The secondary observations included soil analysis, vermicompost organic fertilizer analysis, temperature and humidity. The main observations included observations of plant height, observation of leaf number, observation of fresh plant weight, dry plant weight, and shoot-root ratio.

The data were analyzed using analysis of variance at the level of error α = 5%, and mean difference analyzed using Duncan multiple range test at the significant level of α = 5%.

The research implementation consists of several stages, namely: nursery, preparation of vermicompost, land cultivation, application vermicompost according to treatment for each plot, application salt fertilizer CO(NH₂)₂ (1.56 g), (SP-36 1.94), KCl (0.70 g) for each plant respectively, transplanting, plant irrigation, and harvest.

3. Result and discussion

3.1. Soil properties analysis
The results of soil sample analysis at experimental site showed that the pH of the soil was slightly acidic pH value 6.5. The organic-C and total N were categorized at medium level with successive values of 2.22% and 0.24%. The phosphorus element P-total and P-available were categorized at very high level 81.14 mg 100 g⁻¹ and 35.10 ppm respectively. The potassium element was categorized high 49.46 mg 100 g⁻¹. The soil sample was not contain Al-dd and H-dd, high Cation Exchange Capacity (CEC) of 27.93 kg⁻¹ cmol, and low base saturation 39.24%. The exchangeable potassium element was 0.43 cmol kg⁻¹ soil, exchangeable-Na 0.43 cmol kg⁻¹ soil, and medium exchangeable-Ca 9.44 cmol kg⁻¹ soil. Low exchangeable-Mg 0.66 cmol kg⁻¹. Al saturation is very low at 3.53%. Soil texture includes clay with a sand composition of 23%, 47% dust, and clay 30%.

3.2. Vermicompost properties
Vermicompost analysis have been carried out in the Agro Lembang Chemical Laboratory Service Sub-Unit Bandung give the results that the content of the vermicompost organic fertilizer used in this study has a pH content of 6.77, organic C by 12.43%, N of 0.56 %, P₂O₅ level of 0.42%, K₂O content of 0.33%, and C/N value of 22. Based on the standar minimum of solid organic fertilizer vermicompost quality did not meet all standard criteria especially organic-C and N + P₂O₅+ K₂O below 15% and 4 % respectively [7].

3.3. Temperature and humidity
The results of temperature and humidity measurements using a Thermo hygrometer from February 12 to March 21, 2018, starting from planting (1 DAP) to harvest (38 DAP) is carried out in the morning, afternoon and evening. During the study, the daily temperature ranged from 14 - 28°C with an average morning temperature of 15.86°C, afternoon temperature of 23.34°C, and afternoon temperature of
17.36°C. The average daily temperature of 18.07°C. Air humidity ranged from 80 - 95% with an average morning humidity of 92.21%, afternoon humidity of 84.65%, and afternoon humidity of 90.36%. The average daily humidity is 89.86%. According to land suitability standard the temperature of research site was fulfill the standard requirement between 16-22°C [8].

3.4. Plant height (cm)
Based on the results of the analysis, it is known that the application of vermicompost organic fertilizer has a significant effect on plant height at the ages of 14, 21, and 28 HST, whereas at the age of 35 HST it has no significant effect.

The application of vermicompost 5 t ha\(^{-1}\) fertilizer has an influence on the growth of lettuce plants. Its application of more than 5 t ha\(^{-1}\) differs not significantly with the treatment of 5 t ha\(^{-1}\). The application of vermicompost can improve soil physical properties, soil chemical properties and soil biological properties so that it can increase plant growth [9]. In rice plants, the application of vermicompost 2.5 t ha\(^{-1}\) increases plant height, number of tillers and number of panicles [10].

**Table 1.** Effect of application vermicompost fertilizer on plant height of lettuce plant at age 14, 21, 28, and 35 Day After Plant (DAP).

| Vermicompost Dosages | 14 DAP | 21 DAP | 28 DAP | 35 DAP |
|----------------------|--------|--------|--------|--------|
| K\(_0\)              | 4.13 a | 4.98 a | 7.20 a | 9.05 a |
| K\(_1\)              | 5.10 b | 6.90 c | 10.20 b| 12.00 a|
| K\(_2\)              | 3.75 a | 5.45 ab| 8.10 a | 10.80 a|
| K\(_3\)              | 4.05 a | 6.48 bc| 10.00 b| 11.40 a|
| K\(_4\)              | 4.43 ab| 7.15 c | 9.90 b | 11.80 a|
| K\(_5\)              | 4.43 ab| 6.15 abc| 8.45 ab| 10.15 a|
| K\(_6\)              | 5.10 b | 7.50 c | 10.00 b| 11.70 a|

Remarks: The numbers followed by different lowercase letters in the vertical direction show a significant effect according to the Duncan test at the 5% real level.

3.5. Number of leaves
The results of the analysis of variance showed that various doses of vermicompost at 14, 21, and 28 DAP differed significantly from the number of leaves. At 35 DAP various doses of vermicompost had a significant effect on the number of leaves. Giving vermicompost 5 t ha\(^{-1}\) was significantly different from treatment (k\(_0\)) without vermicompost application and (k\(_3\)) vermicompost 25 t ha\(^{-1}\). Table 2 shows the application of vermicompost 5 t ha\(^{-1}\) affects growth compared to higher doses.

Availability of N and P elements on the soil affects the addition of leaves [4]. However, in this study by increasing the vermicompost dose, plant growth decreased. The humic acid content available at vermicompost doses of more than 5 t ha\(^{-1}\) is thought to affect plant growth [11].
Table 2. Effect of application vermicompost fertilizer on number leaves of lettuce plant at age 14, 21, 28, and 35 Day After Plant (DAP).

| Vermicompost Dosages | Number of Leaves |
|----------------------|------------------|
|                      | 14 DAP | 21 DAP | 28 DAP | 35 DAP |
| K₀                   | 3,30 a  | 3,70 a  | 3,70 a  | 4,40 a  |
| K₁                   | 3,85 a  | 4,30 a  | 4,35 a  | 6,60 a  |
| K₂                   | 3,20 a  | 3,65 a  | 3,90 a  | 5,85 c  |
| K₃                   | 3,35 a  | 4,15 a  | 4,20 a  | 6,20 bc |
| K₄                   | 3,50 a  | 4,00 a  | 4,10 a  | 6,10 bc |
| K₅                   | 3,30 a  | 3,95 a  | 3,65 a  | 5,20 ab |
| K₆                   | 3,55 a  | 3,80 a  | 4,25 a  | 6,30 bc |

Remarks: The numbers followed by different lowercase letters in the vertical direction show a significant effect according to the Duncan test at the 5% real level.

3.6. Fresh plant weight, dry plant weight and shoot-root ratio

Various doses of vermicompost on Fresh Plant Weight parameters, Dry Plant Weight and Shoot-root Ratio did not affect the growth of lettuce plants. The results of the soil analysis showed that the soil at the study site had a low base saturation. The washing process due to high rainfall results in alkaline cations going down to the lower soil horizon so that seasonal plants that have shallow roots cannot reach them.

The availability of N, P, Ca, Fe, and B influences fresh Plant Weight growth parameters, Dry Plant Weight and Shoot-root Ratio [3]. The results of the analysis of the chemical content of vermicompost have N, P and K less than 1% and low Ca-element content [2,12]. Vermicompost properties also contain humic acid when humic acid applied higher concentration on the plant, the humic acid can reduce the growth and the development of the plant [11].

Table 3. Fresh plant weight, dry plant weight and shoot-root ratio.

| Vermicompost Dosages | Fresh Plant Weight (g) | Dry Plant Weight (g) | Shoot-root Ratio |
|----------------------|------------------------|----------------------|-----------------|
| K₀                   | 11.45 a                | 2.54 a               | 3.64 a          |
| K₁                   | 20.03 a                | 4.64 a               | 5.14 a          |
| K₂                   | 15.28 a                | 2.89 a               | 4.93 a          |
| K₃                   | 16.93 a                | 3.56 a               | 4.90 a          |
| K₄                   | 18.25 a                | 4.47 a               | 5.10 a          |
| K₅                   | 12.51 a                | 2.96 a               | 4.59 a          |
| K₆                   | 17.53 a                | 3.99 a               | 5.02 a          |

4. Conclusion

The application of various vermicompost doses affected plant height and number of leaves but did not affect Plant Fresh Weight, Plant Dry Weight and Shoot-root Ratio. The application of vermicompost fertilizer at a dose of 5 t ha⁻¹ is the best dose to support growth and efficiency.
Acknowledgments
We want to thank the Rector of UIN Sunan Gunung Djati and the chairman of LP2M UIN Sunan Gunung Djati have been funded the publication costs through the BOPTN conference assistance scheme and scientific publications in 2019.

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