

Responses of Green *Lettuce* (*Lactuca Sativa* L) Plants to the Application of Various Doses of Kasgot Pupuk (Maggot Waste)

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ABSTRACT

Utilization of vegetable waste can be done by making organic fertilizer assisted by using black soldier fly biodecomposer agents or *Black Soldier Fly*, the resulting fertilizer is maggot (kasgot) fertilizer. The purpose of this study was to determine the effect of organic fertilizer of vegetable waste left over from *maggot* (kasgot) cultivation on the growth and yield of Green *Lettuce* (*Lactuca sativa* L) plants and get the best dose of kasgot fertilizer. This research was conducted at the Technical Implementation Unit (UPT) of the Food Security and Livestock Service Office (DKPP) of Bandung City. This research was conducted from November to July 2024. The method used in this study was group design with 6 treatments with 5 replications, the treatments given were A = Soil + 100%, Urea; B = Kasgot 5 t ha⁻¹ + 50% Urea; C = Kasgot 10 t ha⁻¹ + 50% Urea; D = Kasgot 15 t ha⁻¹ + 50% Urea; E = Kasgot 20 t ha⁻¹ + 50% Urea; F = 20 Kasgot 20 t ha⁻¹. The results showed that fertilizing Kasgot 5 t ha⁻¹ (B) gave the best results on the parameters of plant height and number of leaves of Green Lettuce plants. So fertilization with a dose of 5 t ha⁻¹ + 50% Urea is the recommended fertilization.

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1. INTRODUCTION

The accumulation of organic waste, particularly vegetable waste generated in traditional markets, has become a serious environmental issue that requires immediate attention and sustainable solutions. One of the environmentally friendly approaches to mitigate this problem is by converting vegetable waste into organic fertilizer, which not only reduces the volume of waste but also adds value by improving soil fertility. The process of producing this type of organic fertilizer can be accelerated through the utilization of decomposing organisms, such as the larvae of the black soldier fly (*Hermetia illucens*), commonly known as maggot. These maggots are capable of efficiently decomposing organic waste materials, breaking them down into nutrient-rich organic matter known as kasgot fertilizer or former maggot compost (Wahyuni et al., 2021). Novia et al. (2023) further emphasized that kasgot fertilizer can serve dual functions, both as a planting medium and as an organic fertilizer, given its beneficial nutrient profile.

The organic content in kasgot is particularly advantageous for horticultural crops, including green lettuce (*Lactuca sativa* L.), as it contributes essential macro and micronutrients that support plant growth and development. Supporting this assertion, Rismayanti et al. (2022) reported that the application of kasgot fertilizer to lettuce plants of the Great Alisan variety resulted in significant improvements in several growth and yield parameters, including plant height, number of leaves, dry plant weight, root dry weight, and root-to-shoot ratio. These positive effects can be attributed to the unique composition of kasgot, which is enriched with beneficial microbial communities and bacterial compounds originating from the decomposition process facilitated by BSF maggots. According to Meilani

et al. (2022), these microbial compounds not only supply nutrients but also play a critical role in protecting plants by inhibiting the growth of pathogenic microorganisms, thereby promoting healthier and more vigorous plant development.

2. METHOD

This research was carried out at the Technical Implementation Unit (UPT) of the Food Security and Livestock Service Office (DKPP) of Bandung City, during the period from December 2023 to July 2024. The research utilized a variety of tools to support the implementation of the study, including analytical scales for accurate weight measurements, a thermohygrometer for monitoring temperature and humidity conditions, trays, measuring meters, buckets, dippers, labels for treatment identification, a camera for documentation purposes, mulching materials, and standard stationery for data recording and note-taking. The materials used throughout the experiment consisted of soil as the planting medium, green lettuce seeds of the Grand Rapid variety as the test crop, kasgot fertilizer as the primary organic amendment, polybags as the planting containers, urea fertilizer as the inorganic nutrient source, and water for irrigation. The research employed a Randomized Group Design consisting of six treatment levels.

The treatments were as follows: Treatment A: Control treatment using 100% urea fertilizer at a rate of 250 kg ha⁻¹; Treatment B: Application of 5 t ha⁻¹ kasgot fertilizer combined with 50% of the recommended urea dose (125 kg ha⁻¹); Treatment C: Application of 10 t ha⁻¹ kasgot fertilizer combined with 50% urea (125 kg ha⁻¹); Treatment D: Application of 15 t ha⁻¹ kasgot fertilizer combined with 50% urea (125 kg ha⁻¹); Treatment E: Application of 20 t ha⁻¹ kasgot fertilizer combined with 50% urea (125 kg ha⁻¹); Treatment F: Application of 20 t ha⁻¹ kasgot fertilizer without any addition of urea fertilizer (100% kasgot).

The primary parameters observed during the study included plant height, number of leaves, leaf color, stem diameter, fresh weight, dry weight, root-to-shoot ratio, and harvest index. Data collected from these observations were analyzed statistically using Analysis of Variance (ANOVA) to determine the presence of significant differences among the treatment means. In cases where significant differences were detected, Duncan's Multiple Range Test (DMRT) was performed as a post-hoc analysis to identify specific differences between treatments at the determined significance level.

3. RESULT AND DISCUSSION

1. Plant Height (cm)

Observations on plant height were conducted on a weekly basis at 7, 14, 21, 28, and 35 days after planting (DAP). Based on the data presented in Table 1, it was observed that treatments E and F exhibited a statistically significant effect on plant height at 14 DAP. This indicates that the application of 20 t ha⁻¹ kasgot fertilizer, either in combination with 50% urea (treatment E) or as a sole nutrient source without urea supplementation (treatment F), was able to enhance early vegetative growth compared to the other treatments.

Table 1. Effect of Kasgot Fertilizer on the Average Height of Green Lettuce Plants on age 7, 14, 21, 28 and 35 DAP

Treatment	Average Plant Height (cm)				
	7 DAP	14 DAP	21 DAP	28 DAP	35 DAP
A	3,33 a	6,14 a	12,97 a	16,93 a	19,67 a
B	3,83 a	6,13 a	13,03 a	17,03 a	19,50 a
C	3,56 a	6,15 a	13,27 a	17,07 a	19,84 a
D	3,90 a	6,57 ab	13,03 a	17,07 a	19,94 a
E	4,00 a	7,07 bc	13,27 a	17,23 a	20,87 a
F	4,17 a	7,34 c	13,70 a	17,27 a	20,22 a

Note: The average value in each column marked with the same letter indicates that it is not significantly different based on the Duncan's Further Test at the 5% level

The results of the average plant height measurements indicated that the application of kasgot organic fertilizer had a statistically significant effect on plant height at 14 days after planting (DAP).

However, at subsequent observation periods, specifically at 21, 28, and 35 DAP, the application of kasgot fertilizer alone or in combination with urea did not show a statistically significant difference compared to the control treatment (100% urea). Nevertheless, it is noteworthy that the treatments involving kasgot fertilizer were able to achieve plant height values comparable to the control, suggesting that kasgot fertilizer can partially substitute for inorganic nitrogen fertilizer, particularly during the early stages of vegetative growth. The absence of significant differences after 14 DAP can be attributed to the delayed availability of nutrients from the kasgot fertilizer, which may have been influenced by the recent application of supplementary fertilizer. As a result, the nutrient requirements of the lettuce plants, especially nitrogen (N), were not fully met during the observation periods of 21 to 35 DAP, which are critical stages for vegetative growth and development.

This finding is consistent with the study conducted by Fauzi et al. (2022), which demonstrated that increasing the application dose of kasgot fertilizer led to improved nutrient availability in mustard plants, which in turn promoted plant height development. Similarly, research by Putri et al. (2024) reported that the application of kasgot fertilizer at a dose of 15 t ha⁻¹ resulted in significant improvements in plant height in lettuce crops, highlighting the potential of kasgot fertilizer to support optimal plant growth under appropriate dosage levels.

Furthermore, according to Musadik and Agustin (2021), the availability of nitrogen plays a critical role in stimulating stem and leaf growth during the vegetative phase, which directly contributes to increases in plant height and the number of leaves. Supporting this, Nurdin (2017) emphasized that throughout all stages of plant growth, nitrogen is required in relatively high amounts, particularly during the vegetative growth stage, where it is essential for promoting the development of roots, stems, leaves, and overall plant height. This is also aligned with the findings of Laksono (2020), who stated that adequate nitrogen availability is crucial to ensure robust vegetative growth in lettuce plants.

2. Number of Leaves

Based on the data presented in Table 2, it was observed that treatments A through E had a significant effect on the number of leaves at 35 days after planting (DAP). The number of leaves in lettuce plants under these treatments showed a statistically significant increase compared to treatment F, which did not exhibit the same level of response. This finding highlights the importance of nitrogen availability in supporting leaf development, particularly during the later stages of vegetative growth.

The enhanced leaf production observed in treatments A to E can be attributed to the addition of urea fertilizer, which served to supplement the nutrient requirements of the plants, particularly nitrogen (N). Nitrogen is a critical macronutrient responsible for stimulating chlorophyll formation, protein synthesis, and overall vegetative growth, including leaf expansion and development. The combination of kasgot with urea, as applied in treatments B to E, allowed the plants to access both organic and inorganic nutrient sources, thus ensuring sufficient N availability to support optimal leaf production at 35 DAP.

In contrast, treatment F, which solely relied on the application of 20 t ha⁻¹ kasgot fertilizer without any supplementation of urea, failed to meet the nitrogen needs of the plants, as reflected by the lower number of leaves recorded. This can be explained by the relatively low nitrogen content typically found in kasgot fertilizer, which is derived from the residue of Black Soldier Fly (BSF) larvae feeding on organic waste. While kasgot contributes beneficial organic matter and some essential nutrients, its nitrogen concentration alone was insufficient to sustain the high N demand of lettuce plants during critical vegetative growth stages, particularly in promoting the formation of new leaves.

These results are in line with previous research suggesting that while kasgot can serve as a valuable organic fertilizer, it is often necessary to combine it with an external nitrogen source, such as urea, to achieve optimal plant growth and yield (Fauzi et al., 2022; Musadik & Agustin, 2021). Without this supplementation, the limited N availability from kasgot alone may constrain the vegetative performance of lettuce, particularly in terms of leaf production.

Table 2. Effect of Kasgot Fertilizer on the Average Number of leaves of Green Lettuce Plants at the age of 7, 14, 21, 28 and 35 DAP

Treatment	Average Number of Plants				
	7 DAP	14 DAP	21 DAP	28 DAP	35 DAP
A	3,47 a	5,27 a	6,93 a	11,47 a	14,27 b
B	3,67 a	5,53 a	7,33 a	10,93 a	12,93 b
C	3,80 a	5,47 a	7,13 a	11,20 a	13,20 b
D	4,00 a	5,47 a	7,27 a	12,20 a	14,27 b
E	4,00 a	5,93 a	8,20 a	12,13 a	14,20 b
F	4,27 a	5,53 a	7,47 a	11,60 a	11,67 a

Note: The average value in each column marked with the same letter indicates that it is not significantly different based on the Dunan's Further Test at the 5% level.

In the analysis of the number of leaves parameter, the best performance was observed in the treatment involving the application of 5 t ha⁻¹ kasgot fertilizer combined with 50% urea fertilizer (Treatment B). This treatment not only produced a higher number of leaves but also demonstrated the potential to reduce the dependency on synthetic urea fertilizer by up to 50%. The utilization of kasgot organic fertilizer, which is known to contain essential nutrients, particularly nitrogen (N), contributed significantly to enhancing soil nutrient status, thereby improving plant growth performance.

The availability of nitrogen from kasgot fertilizer plays a pivotal role in increasing leaf greenness, which is an indirect reflection of chlorophyll content in the leaves. Increased chlorophyll concentration supports the efficiency of the photosynthetic process, which in turn stimulates the production of new leaves and promotes vigorous vegetative growth. The improvement in the number of leaves under Treatment B can also be attributed to the adequate nitrogen content supplied by the combination of kasgot and urea fertilizer, as confirmed by the nutrient analysis of kasgot presented in Table 3. This nutrient combination ensured that the nitrogen requirements of the lettuce plants were sufficiently met, enabling optimal physiological processes related to leaf development.

Moreover, an increased number of leaves is crucial for enhancing the photosynthetic capacity of the plant, as a larger leaf area allows for more light interception, which drives photosynthesis and accelerates plant growth and biomass accumulation. This is in accordance with the findings of Indrianasari (2014), who stated that nitrogen is the key nutrient influencing the number of leaves, as its adequate availability ensures rapid and vigorous vegetative development, particularly in leafy vegetable crops such as lettuce.

Table 3. Effect of Kasgot Fertilizer on Leaf Area of Green Lettuce Plants

Treatment	Average (cm ²)
A	149,05 a
B	143,63 a
C	139,61 a
D	154,13 a
E	159,97 a
F	155,81 a

Note: The average value in each column marked with the same letter indicates that it is not significantly different based on the Dunan's Further Test at the 5% level

As a complement to its role in protein synthesis, nitrogen is an integral part of the chlorophyll molecule and therefore the provision of sufficient N will result in vigorous vegetative growth and fresh green color. Therefore, sufficient N can also help the process of weathering organic matter to be more perfect (Agustin et al., 2023).

3. Stem diameter (mm)

The data presented in Table 4 shows that the analysis of variance for stem diameter observations across all treatments revealed no statistically significant differences. Among the treatments, the highest mean stem diameter was observed in the treatment with 20 t ha⁻¹ kasgot fertilizer combined with 50% urea (Treatment E). This outcome suggests that even with the highest fertilizer dose, the nutrient requirements for maximizing stem diameter growth were not fully achieved.

One possible explanation for this is the slow-release nature of kasgot fertilizer, which results in a gradual nutrient availability over time, thus potentially delaying immediate plant growth responses such as stem thickening. Additionally, the relatively low concentrations of phosphorus (P) and potassium (K) in kasgot fertilizer may have limited its effectiveness in promoting stem diameter development, as these macronutrients are essential for cell division, elongation, and overall structural growth of plants.

Other environmental or physiological factors may also have influenced stem diameter growth, but based on the fertilizer treatments, it can be concluded that kasgot fertilizer alone or in combination with partial urea supplementation was insufficient to significantly enhance stem diameter during the experimental period.

Table 4. Effect of Kasgot Fertilizer on Stem Diameter of Green Lettuce Plants

Treatment	Average (mm)
A	16,62 a
B	17,84 a
C	17,89 a
D	14,92 a
E	17,90 a
F	17,23 a

Note = The average value in each column marked with the same letter indicates that it is not significantly different based on the Dunan's Further Test at the 5% level

4. Dry weight of stalk (g)

The data presented in Table 5 indicate that none of the treatments had a statistically significant effect on the dry weight of the stalk. This lack of significant difference may be attributed to the characteristics of the soil used in the experiment, which contained a high clay content. Soils with high clay content tend to have specific physical and chemical properties that can influence nutrient availability and root development, thereby affecting overall plant biomass accumulation. Moreover, nitrogen plays a critical role in plant growth, particularly in relation to chlorophyll production and photosynthesis during the vegetative phase.

Nitrogen deficiency often results in leaf yellowing (chlorosis) and a consequent reduction in photosynthetic efficiency, limiting biomass production. Conversely, an excess of nitrogen can cause the foliage to become excessively dark green but does not necessarily translate into increased dry matter accumulation in stems or stalks (Nugroho, 2015). The balanced nitrogen supply is therefore essential for optimizing both photosynthesis and biomass partitioning. In this study, it is possible that the nitrogen levels provided by the different fertilizer treatments, combined with soil characteristics, did not create significant variations in stalk dry weight. This suggests that factors other than nitrogen availability, such

as soil texture and nutrient interactions, might have had a greater influence on dry weight outcomes under the conditions tested.

Table 5. Effect of Kasgot Fertilizer on the Average Dry Weight of Green Lettuce Plant Stalks

Treatment	Average (g)
A	7,91 a
B	8,30 a
C	8,10 a
D	7,95 a
E	8,68 a
F	7,94 a

Note: The average value in each column marked with the same letter indicates that it is not significantly different based on the Dunan's Further Test at the 5% level

Plants grown in clay soils often face challenges related to root development due to the soil's physical properties, such as poor aeration and waterlogging, which can limit root respiration. This limitation in root function reduces the translocation of photosynthates within the plant, ultimately resulting in lower dry weight accumulation.

Additionally, the unfavorable soil conditions compel lettuce roots to expend more energy to adapt and function, further impacting overall plant biomass production (Nurmayulis et al., 2014). Plant dry weight serves as an important indicator of the nutritional status and overall health of a plant. It reflects the cumulative outcome of growth and development processes, which are closely linked to the availability and uptake of essential nutrients. According to Larcher (1975), plant dry weight represents the net accumulation of carbon dioxide (CO₂) assimilated through photosynthesis during the plant's life cycle. Therefore, optimal nutrient availability and favorable environmental conditions are critical to maximizing dry matter production and ensuring healthy plant growth.

5. Root Length (cm)

The data presented in Table 6 indicate that there was no significant effect of the treatments on root length. This result can be attributed to the characteristics of the clay soil used in the study, which has a dense structure and low porosity. The limited pore space and poor aeration in clay soils hinder root penetration and expansion, thereby restricting root length development. The lack of sufficient soil cavities and narrow soil aggregates reduce root growth potential by limiting oxygen availability and increasing soil resistance to root movement.

Table 6. Effect of Kasgot Fertilizer on the Average Root Length of Green Lettuce Plants

Treatment	Average (cm)
A	7,91 a
B	8,30 a
C	8,10 a
D	7,95 a
E	8,68 a
F	7,94 a

Note = The average value in each column marked with the same letter indicates that it is not significantly different based on Dunan's Further Test at 5% level

According to Arsyadiah (2015), root length is strongly influenced by the availability of adequate nutrients, which supports optimal plant growth. Longer roots enhance the plant's ability to absorb nutrients and water, thereby facilitating proper development and physiological functions (Laksono & Nurlenawati, 2021). In addition to nutrient availability, the physical properties of the planting medium also play a critical role in root growth. Specifically, the clay texture of the soil used in this study poses

challenges for root elongation. As noted by Pujawan et al. (2016), an increase in soil bulk density leads to a reduction in the number of soil macropores, which in turn limits root diameter and impedes the roots' ability to penetrate soil pores. Consequently, higher soil density negatively affects root expansion and overall root length.

6. Root Pupil Ratio

The data presented in Table 7 indicate that the treatments had no significant effect on the root pupil ratio (NPA). The results predominantly tended towards increased pupus values, suggesting that the treatments did not notably influence this parameter during the study period.

Table 7. Effect of Kasgot Fertilizer on the Average Root Pupil Ratio of Green Lettuce Plants

Treatment	Average (cm)
A	4,51 a
B	5,69 a
C	6,10 a
D	6,17 a
E	5,25 a
F	4,16 a

Note : The average value in each column marked with the same letter indicates that it is not significantly different based on the Dunan's Further Test at the 5% level

According to Irwan et al. (2017), a root pupus ratio greater than one indicates that plant growth is more directed towards pupus development, whereas a ratio less than one suggests growth is more focused on root development. When growth is predominantly towards pupus, root formation can be inhibited. One potential cause of this inhibited root growth is the deficiency of available phosphorus (P) in the soil, resulting in insufficient P uptake by the roots. Phosphorus is a key nutrient that stimulates root growth, which subsequently influences the development of the aboveground shoot system. Winarso (2003) further explains that plants grown in environments with adequate phosphorus exhibit better biomass allocation and overall growth compared to those grown under phosphorus-deficient conditions. If you want, I can help you connect this explanation to your data or results.

7. Fresh Weight

The fresh weight of the crop showed no significant effect across treatments. This outcome is likely because fresh weight is strongly influenced by plant height and leaf number; taller lettuce plants with more leaves generally have higher fresh weights. Fresh weight represents the accumulation of photosynthates in the form of plant biomass combined with water content in the leaves (Nurmayulis et al., 2014). The application of kasgot fertilizer in this study did not achieve optimal production results, likely due to insufficient fulfillment of the plant's nutrient requirements.

Additionally, the clay soil's physical characteristics limited root system development and reduced water absorption because of narrow soil pores and low aeration. Another factor impacting fresh weight was the high light intensity observed during the measurement period, which caused premature leaf senescence prior to harvest. Khoiriyah et al. (2023) reported that excessive light intensity can reduce photosynthesis rates due to rapid photooxidation of chlorophyll, leading to its damage. Conversely, insufficient light limits photosynthesis, causing the plant to consume more stored food reserves than it produces. Furthermore, high light intensity often coincides with reduced air humidity, which accelerates the transpiration rate, further stressing the plants..

4. CONCLUSION

Based on the results of the study, the application of kasgot fertilizer with vegetable waste feed had no significant effect on the growth and yield of green lettuce (*Lactuca sativa* L.). However, the most effective dose of kasgot fertilizer with vegetable waste feed in enhancing the growth and yield of green lettuce (*Lactuca sativa* L.) was found at a rate of 5 t ha⁻¹ combined with 50% of the recommended Urea dose.

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