DOI :https://doi.org/10.36378/juatika.v4i1.1798
JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL.4 NO. 1 January 2022
eissn 2656-1727
pissn 2684-785X
Hal : 26 – 36

Growth Response and Yield Of Lettuce (*Lactuca Sativa* L.) On Top Soil Alfisol Planting Media From Jamaimo Village, Mariat District, Sorong Regency To Bio Boost Fertilizer Treatment

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Abstract

Lettuce has great potential to be developed. However, the limited condition of agricultural land in Indonesia requires alternative for efficient cultivation systems that can maintain the yield and growth of lettuce plants. Therefore, the cultivation carried out in this study was cultivation on narrow land with polybags using planting media top soil Alfisoll from Jamimo Village, Mariat District, Sorong Regency. Considering this, a study was conducted to determine the effect of best concentration of liquid Bioboost organic fertilizer in increasing the growth and yield of lettuce on Alfisol top soil planting media. This research was conducted in Klawuyuk Village, Sorong City, and analyzed soil samples at the Chemistry and Soil Fertility Laboratory, Department of Soil Science, Faculty of Agriculture, Hasanuddin University Makassar. This study used a Completely Randomized Design (CRD) with one treatment factor, namely the concentration of Bio-Boost liquid organic fertilizer which consisted of 4 treatment levels, namely 1) without Bio-Boost liquid organic fertilizer (control)); 2) 60 ml Bio-Boost liquid organic fertilizer + 1 liter of water 3) 80 ml Bio-Boost liquid organic fertilizer + 1 liter of water; 4)100 ml Bio-Boost liquid organic fertilizer + 1 liter of water. Observational data were analyzed statistically with analysis of variance at the 5% level. The dosage of Bio-Boost liquid organic fertilizer gave a very significant effect on the growth and yield of lettuce on Alfisol top soil planting media, where the concentration of B2 treatment (80 ml of Bio-Boost liquid organic fertilizer + 1 liter of water) resulted in variables growth and the highest yield, namely plant height 39.5 cm, several leaves 11, leaf area 91.3 cm, and wet weight 610, 4 gr.
Keyword*: Lettuce, Bio-Boost, Alfisol*

1. INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a type of leaf vegetable plant that is well known among the public. Lettuce contains fiber, vitamins, fresh taste, and a variety of substances that are beneficial to the body, making lettuce a commodity favored by the wider community. In addition, lettuce can also provide adequate profits for cultivators. Direktorat Jenderal Hortikultura (2015) reported that lettuce production from 2011 to 2014 was 287,750 tons, 294,934 tons, and 280,969 tons respectively. The data shows that in 2014 lettuce production decreased. According to the Badan Pusat Satistik (2016), in 2014 lettuce production in Indonesia was below 1000 tons/year, while lettuce consumption was 1,296 tons/year. To meet the needs, lettuce must be imported from several foreign countries.

This is in line with Wijaya & Fajeriana, 2018) who stated that lettuce (*Lactuca sativa L*) is a plant that has many benefits and has a fairly high economic value. Therefore, lettuce cultivation has great potential to be developed. However, the limited condition of agricultural land in Indonesia requires choosing alternative for efficient cultivation systems to maintain the yield and growth of lettuce plants.

Important factors in cultivation that support the success of lettuce production are soil problems, fertilization, climate, seeds quality, and control of pests and diseases.

In terms of planting media, lettuce can be planted on soil that has nutrient content based on the needs of lettuce plants such as Alfisol soil. Alfisols have geographical and agro-climatic conditions that encourage them to become marginal soils. There are some problems of marginal soils, from too alkaline ((pH>7) to too acidic ((pH<5), shallow solum, low organic matter, poor macro (N, P, K, Mg, and S), and micro (Fe and ZN) nutrients), low water retention, and poor soil drainage. Alfisol soil that experienced erosion is less favorable for plant growth. This is because the argillic horizon will be exposed to the outside as the top layer, and this layer can inhibit plant growth, especially root growth. Therefore, the planting medium used, namely Alfisol topsoil, was analyzed by a laboratory to see the nutrient content which then became a fertilizer recommendation. According to Fajeriana M & Wijaya (2020), soil fertility analysis is a way of assessing the status of nutrients in the soil so that it helps in determination of plant species and recommendations for appropriate fertilization. Furthermore, Pinatih et al., (2015) state that the nutrient requirements needed by plants for growth and production are determined by the ability of the soil to provide nutrients for plants and cannot always be met.

Decreasing soil fertility can be the main factor affecting soil productivity so that the addition of nutrients in the soil through the fertilization process is very important to do to obtain profitable agricultural production.

The use of controlled-release fertilizers (slow-release fertilizers) will help meet the availability of nutrients for plants. Fertilization of lettuce on Alfisol soil is done by using organic fertilizer, namely Bioboost liquid organic fertilizer (POC). Bio boost is a biological fertilizer containing superior micro-organisms and is beneficial in increasing soil fertility as a result of soil biochemical processes. Bio boost fertilizer is known to contain natural growth hormones such as gibberellins, cytokinins, kinetin, zeatin, and auxin Indole Acetic Acid (IAA). According to research by Sangadji et al., (2021), the addition of Bioboost bio fertilizer to the soil can increase the CEC value which will increase the soil's ability to absorb nutrients better so that the nutrients are not easily washed out by water because the nutrients are present in the colloid adsorption complex. In line with the results of this study, Indriana et al., (2021) stated that the application of Bioboost biofertilizers in the form of soil microbes can affect the physical, chemical, and biological properties of the soil. The availability of nutrients in the soil will affect plant growth and yield, and the ability of roots to absorb nutrients will be better. Considering this, a study was conducted to determine the best

concentration of Bioboost liquid organic fertilizer in increasing the growth and yield of lettuce on Alfisol top soil planting media.

2. RESEARCH METHODS

This research was conducted in Klawuyuk Village, Sorong City from August to October 2020. The analysis of soil sample was conducted in Chemistry and Soil Fertility Laboratory of the Department of Soil Science, Faculty of Agriculture, Universitas Hasanuddin Makassar.

The materials used in this study consisted of lettuce seeds, Alfisol top soil planting media from Jamaimo Village, Mariat District, Sorong Regency, drum fertilizer, and Bioboost liquid fertilizer. The tools used were a hoe, shovel, soil raking, bucket, scale, meter, measuring cup, scissors, digital camera, and writing utensils.

This study used Completely Randomized Design (CRD) with one treatment factor, namely the concentration of Bioboost liquid organic fertilizer which consisted of 4 levels of treatment, namely: 1) no Bioboost liquid organic fertilizer (control); 2) 60 ml Bioboost liquid organic fertilizer + 1 liter of water; 3) 80 ml Bioboost liquid organic fertilizer + 1 liter of water; and 4) 100 ml Bioboost liquid organic fertilizer + 1 liter of water.

This level of treatment was repeated 3 times to obtain 12 treatment units. Each treatment consisted of 3 lettuce plants, thus there were 36 lettuce plants used as sample plants for observation purposes.

The determination of this treatment dose was based on the results of Driyunitha & Pasapan (2016) where the use of Bioboost fertilizer on strawberry plants at a dose of 80 ml + 1 liter of water gave the best results for all components of growth and yield of lettuce.

Research Implementation

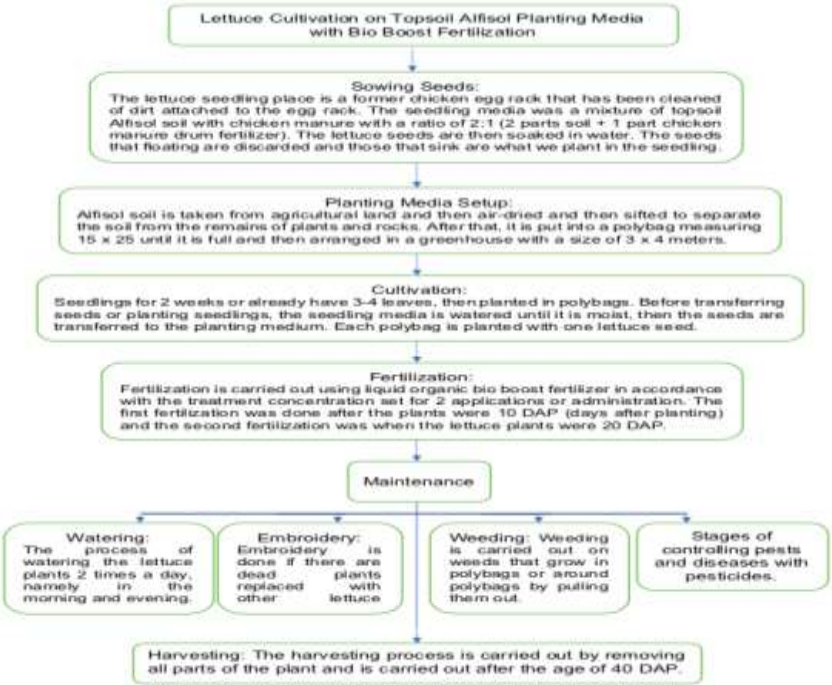

Figure 1: Flowchart of Research Implementation

Observation Variable

1. Lettuce Plant Height
   Measurement of plant height was conducted when the lettuce plants were 20 Days After Planting (DAP), 30 DAP, and 40 DAP. Measurement of plant height was conducted from the base of the lowest stem (from ground level) to the tip of the highest plant by straightening the lettuce leaves up.
2. Number of Lettuce Plant Leaves
   For the variable of observing the number of lettuce leaves, observations were conducted from plants aged 20 DAP, 30 DAP, and 40 DAP.
3. Leaf Area of Lettuce
   Measurement of the leaf area of lettuce plants was done by using a meter. Measurement of leaf area of lettuce was carried out when the plant was 40 DAP. Measurement of leaf area was carried out by referring to Gardner et al., (2011) formula, namely:

   A = P x L X K
   A = Leaf area (cm2);
   P = Leaf Length (cm);
   L = Leaf width (cm);
   K = Constant (0.75).
4. Lettuce Plant Wet Weight
   Wet weight was measured when the plant was 40 DAP. Each plant sample based on the dose of Bioboost liquid organic fertilizer was washed using clean water, then air-dried, and then weighed.

Data analysis

Observational data were analyzed statistically with analysis of variance at the 5% level. If the treatment had a significant effect, it then proceeded to DMRT test at a confidence level of 0.05.

3. RESULTS AND DISCUSSION

Soil Fertility Analysis Results

From the results of the analysis of soil sample in the laboratory, it can be seen that the data on soil fertility before planting can be seen in Table 1.

Table 1. Soil Fertility Data Processing for Soil Sample

Type of Soil	Soil Properties	Unit of measure	Results	Category
Alfisol	pH H_2O	-	5,75	bit sour
	N Total	%	0,96	Low
	P Available (P_2O_5)	Ppm	8,72	Currently
	CEC	cmol kg^{-1}	20,73	Currently
	Ca	cmol kg^{-1}	5,30	Currently
	Mg	cmol kg^{-1}	0,48	Low
	K	cmol kg^{-1}	0,22	Low
	Na	cmol kg^{-1}	0,22	Low
	C-Organic	%	0,96	Low
	N-Organic	%	0,17	Low
	C/N	-	6	Low
	Texture	-	Clay clay	Slightly smooth

Source: Primary Data after processing, 2020.

Based on the data from Table 1, Alfisol soil has a C-Organic material content of 0.96% and this is low. Thus, it is necessary to add organic fertilizer. The content of total N and nutrients in the soil is in *low* to *medium* category. The clay texture of the soil also causes the soil to have high water holding capacity but low water leaching capacity. This is by Pathak et al., (2013) that characteristics of Alfisol soil are that: 1) it contains a lot of clay as a result of the accumulation of the above horizons. It is a high density soil that make it difficult for plant roots to penetrate; 2) it has low organic matter content and has low soil aeration pores. The CEC value of Alfisol is in the *medium* category. According to Syarief (1986), the fertility rate of Alfisol can be seen from the value of Cation Exchange Capacity (CEC); the higher the CEC value means the more fertile the Alfisol is. Therefore, fertilization with Bioboost organic fertilizer must be carried out to be able to add nutrients to the soil as well as to improve soil structure. Organic fertilizers are very important because they improve soil structure, increase soil absorption of water, improve living conditions in the soil and contain plant nutrients.This is following Sangadji et al., (2021) who stated that the contents of organic matter in Bioboost fertilizers can improve soil structure and texture. Besides, it contain microorganisms, auxin and cytokinin hormones that can stimulate plant growth. The content of microorganisms in Bioboost biofertilizers can increase nutrient uptake from the soil.

Lettuce Plant Height

Based on the results of further tests using the 5% DMRT test, this dose treatment showed significant differences in each trement at the age of 20 DAP, 30 DAP, and 40 DAP.

Table 2. Effect of Bioboost liquid organic fertilizer dose on lettuce plant height at the age of 20 DAP, 30 DAP, and 40 DAP.

Treatment	Observation Day		
	20 DAP	30 DAP	40 DAP
No Bioboost liquid organic fertilizer (control)	11,3 bc	15,9 c	20,5 cd
60 ml Bioboost liquid organic fertilizer + 1 liter of water	12,2 bc	22,4 b	28,6 bc
80 ml Bioboost liquid organic fertilizer + 1 liter of water	16,3 a	30,1 a	39,5 a
100 ml Bioboost liquid organic fertilizer + 1 liter of water	14,1 b	27,2	33,5 b
DMRT 0,05	2,2	3,9	5,6

Note: Numbers followed by the same letter in the same column are not significantly different according to the 5% level of the DMRT test.

The effect of the treatment dose of Bioboost liquid organic fertilizer on lettuce plant height based on the results of the study showed that the treatment had a significant effect on each application of Bioboost concentration. The nutrient content of N, P, and K greatly affects the level of soil fertility. The nutrient content of C-organic Alfisol soil used as a medium for growing lettuce

based on the results of laboratory tests is only 0.95% and is included in the low category, but with the provision of 80 ml of bio boost fertilizer + 1 liter of water, it can provide sufficient nutrients for the soil so that it can produce the highest average plant height, namely in treatment B2 (Bioboost liquid organic fertilizer 80ml + 1 liter of water) which is 39.5 cm until 40 days after planting and the lowest is in treatment B0 (without Bioboost liquid organic fertilizer /control) with a plant height of 20.5 cm at the age of 40 DAP. This increase in lettuce height is assumed to be due to the application of Bioboost liquid organic fertilizer causing the cell at the tip of the stem to be pushed or to immediately conduct cell division, especially in the meristematic area because Bioboost organic fertilizer contains superior microorganisms and is useful for increasing soil fertility as a result of soil biochemical processes and it also contains macronutrients (nitrogen, phosphorus, and potassium) and micronutrients. This is following the statement of Manuhuttu et al., (2018) that Bioboost is a biological fertilizer containing superior microorganisms, and is useful for increasing soil fertility as a result of soil biochemical processes. The composition of Bioboost fertilizer is as follows: (1) Azotobacter sp which acts as a nitrogen fixer, (2) Azospirillum sp which acts as a nitrogen fixer, (3) Bacillus sp that plays a role in the decomposition of organic matter, (4) Pseudomonas sp that plays a role in residue decomposition pesticides, and (5) Cytophaga sp that plays a role in the decomposition of organic matter. Bio boost fertilizer is also known to contain natural growth hormones such as gibberellins, cytokinins, kinetin, zeatin, and auxin Indole-3-Acetic Acid (IAA).

Number of Lettuce Plant Leaves

Table 3 shows the effect of the treatment dose of Bio boosts liquid organic fertilizer on the number of lettuce leaves at the age of 20 DAP, 30 DAP, and 40 DAP. The highest average number of leaves was produced by treatment with a dose of 80 ml of Bioboost liquid organic fertilizer + 1 liter of water (B2) and based on the results of the 5% DMRT test, this treatment was significantly different from other treatments.

Table 3. Effect of Bioboosts liquid organic fertilizer dose on the number of lettuce leaves at the age of 20-40 days after planting.

Treatment	Observation Day		
	20 DAP	30 HST	20 DAP
No Bioboost liquid organic fertilizer (control)	3 cd	4 d	5 d
60 ml Bioboost liquid organic fertilizer + 1 liter of water	5 bc	6 c	7 c
80 ml Bioboost liquid organic fertilizer + 1 liter of water	8a	9 a	11 a
100 ml Bioboost liquid organic fertilizer + 1 liter of water	6 b	7 b	9 b
DMRT 0,05	1,5	1,6	1,9

Note: Numbers followed by the same letter in the same column are not significantly different according to the 5% level of the DMRT test.

The effect of Bioboost liquid organic fertilizer treatment on the number of lettuce leaves can be seen that the taller the lettuce plant, the more leaves formed. The dose treatment of Bioboost B2 liquid organic fertilizer (80 ml bio boost + 1 liter of water) produced the highest number of leaves, namely 11 leaves until 40 DAP, and the least number of leaves was produced by treatment B0 (without Bioboost/control fertilizer treatment). Treatment of Bio boost liquid organic fertilizer 80 ml + 1 liter of water can increase soil fertility as a result of soil biochemical processes because Bioboost fertilizer as a biological fertilizer contains soil microorganisms that can increase soil absorption capacity for air and water, and thus increase lettuce plant growth by increasing the number of leaves. According to Suriadikarta (2006) in (Wardhana et al., 2016), Bioboost organic fertilizers have important chemical functions such as providing macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur) and micronutrients such as zinc, copper, cobalt, manganese, and iron. The availability of these elements can increase soil fertility because in the soil organic fertilizer will be overhauled by microorganisms into humus or soil organic matter.

In general, plant leaves are the main photosynthetic producing organs. The large number of leaves will provide more places for photosynthesis so that more photosynthate will be obtained. The number of leaves is closely related to plant height because the leaves are organs located in the lettuce stem book. This is in accordance with the opinion of Gardner et al. (2011) that the addition of plant height can directly increase the number of leaves containing chlorophyll pigment which functions to absorb light to be used in the photosynthesis process to produce carbohydrates (glucose) and oxygen.

Plant Leaf Area

The average leaf area of the largest lettuce plant at the time the plant was 40 DAT that was produced by treatment B2 (80 ml of Bioboost fertilizer + 1 liter of water), and based on further tests using 5% BNJ this treatment was significantly different.

Table 4. Effect of Bioboost liquid organic fertilizer dose on leaf area (cm) of lettuce plants at 40 days after planting.

Treatment	Leaf area (cm) 40 DAP
No liquid Bioboost organic fertilizer (control)	33,4 cd
60 ml Bioboost liquid organic fertilizer + 1 liter of water	67,4 bc
80 ml Bioboost liquid organic fertilizer + 1 liter of water	91,3 a
100 ml Bioboost liquid organic fertilizer + 1 liter of water	74,5 b
DMRT 0,05	18,7

Note: Numbers followed by the same letter in the same column are not significantly different according to the 5% level of the DMRT test.

The effect of the treatment on lettuce leaf area showed that the dose of Bioboost liquid organic fertilizer B2 (80 ml of Bioboost fertilizer + 1 liter of water) produced the largest average leaf area at the age of 40 DAP which was 91.3 cm. Based on the results of the DMRT test 5%, treatment B2 (80 ml of Bioboost fertilizer + 1 liter of water) was significantly different from treatment B3 (100 ml of Bioboost fertilizer + 1 liter of water) and very significantly different from treatment B1 (60 ml of Bioboost fertilizer + 1 liter of water) and B0 treatment (without Bioboost fertilizer/control). The large leaf area produced in treatment B2 (80 ml of Bioboost fertilizer + 1 liter of water) was due to the nitrogen contents contained in it are capable of meeting the nutrient needs of lettuce. In addition, nitrogen nutrients produced by microorganisms contained in Bioboost fertilizers can bind nitrogen from the air for being used by plants. This proves that the B2 treatment (80 ml of Bioboost fertilizer + 1 liter of water) can increase the N nutrient content in Alfisol soil because the results of laboratory analysis on soil sample before planting wasonly 0.96% are in a low category; meanwhile, lettuce plant in its growth requires sufficient nitrogen nutrients for the growth of its vegetative tissues. This is in line with Ulhair et al., 2020) who states that Bioboost fertilizer contains free nitrogen-fixing bacterial microorganisms that will help provide nitrogen for plants so that the increase in leaf area is caused because the fertilizer provides nitrogen needed by plants for growth. Furthermore, (Junaedi et al., (2019) mentioned that Bioboost biofertilizers are also known to contain natural growth hormones such as gibberellins, cytokinins, kinetin, zeatin, and auxin Indole Acetic Acid (IAA); this can also support leaf growth. Lettuce is a plant whose leaves are harvested, thus nitrogen elements are needed by the plants so that the growth and development of lettuce leaves take place properly. The larger the leaf area, the higher the quality of the plant and the higher the selling value. Leaf area parameters can provide an overview of the process and rate of photosynthesis in a plant. This is by Weiss et al. (1991) in Fajeriana et al., (2013) who states that leaves that have a high chlorophyll contents are more efficient in capturing sunlight energy for photosynthesis. Greener leaves have higher chlorophyll content, and wider leaf surfaces contain more chlorophyll. The investment of photosynthetic results in vegetative organs that greatly determines productivity at the next level of development, namely generative and crop yields.

Lettuce Plant Wet Weight

From the average wet weight of lettuce, the best at 40 days after planting (DAT) was produced by treatment B2 (80 ml of Bioboost fertilizer + 1 liter of water).

Table 5. Effect of Bioboost liquid organic fertilizer dose on wet weight (gr) of lettuce at 40 days after planting.

Treatment	Wet Weight 40 HST (gr)
No liquid Bioboost organic fertilizer (control)	293,7 cd
60 ml Bioboost liquid organic fertilizer + 1 liter of water	433,7 bc
80 ml Bio boost liquid organic fertilizer + 1 liter of water	610,4 a
100 ml Bio boost liquid organic fertilizer + 1 liter of water	498,9 b
DMRT 0,05	92,4

Note: Numbers followed by the same letter in the same column are not significantly different according to the 5% level of the DMRT test.

Based on the table above, it shows that the effect of treatment on the wet weight of lettuce plants is that treatment B2 (80 ml of Bioboost fertilizer + 1 liter of water) produced the heaviest average wet weight at the age of 40 DAP which was of 610.4 gram. Based on the results of the BNJ further test 5%, treatment B2 (80 ml of Bioboost fertilizer + 1 liter of water) was significantly different from treatment B3 (100 ml of Bioboost fertilizer + 1 liter of water) and very significantly different from treatment B1 (60 ml of Bio boost fertilizer + 1 liter of water) and B0 treatment (without Bio boost/control fertilizer). The *low* to *moderate* content of macronutrients N, P, K and micronutrients Ca, Mg, and Na in Alfisol soil before planting may result in insufficient nutrients needed by plants lettuce for growth and development so that it can produce low plant fresh weight. This shows that the fresh weight of the plant is also influenced by the state of the nutrients available in the growing media because the use of Bio boost biofertilizers containing microorganisms as well as macro and micronutrients and growth hormones can increase soil fertility; thus creating optimal conditions for plant roots so that roots can grow and plants will develop well. According to Pathak et al., (2013), the main characteristic of Alfisol is that it experiences a lot of clay accumulation from the horizons above so that it has a high density of soil; therefore, it is difficult for plant roots to penetrate. Alfisols soil also contains low organic matter content, aeration pores, and water holding capacity. Element P is one of the main nutrients that are essential for plants in addition to nitrogen, potassium, and other microelements. Furthermore (Karamina & Fikrinda, 2016), the content of macro and micronutrients in organic bio boost fertilizer can stimulate plant metabolism. Nitrogen contained in liquid organic fertilizer acts as a constituent of protein while Phosphorus and Calcium play a role in stimulating meristem tissue division and stimulating root growth and leaf development.

The response of lettuce plants to the treatment of Bioboost liquid fertilizer showed that in treatment B3 (100 ml of Bio boost fertilizer + 1 liter of water) with had a higher concentration but caused plant height, number of leaves, leaf area, and wet weight of lettuce plants to decrease compared to B2 (80 ml) Bio boost fertilizer + 1 liter of water) which shows all the best observation variables. This is because lettuce plants experience excess nutrients so that plant roots are not able to absorb nutrients optimally.

This is following Lamawulo et al., (2017), who stated that the decrease in plant height, number of leaves, leaf area, and wet weight of plants due to the addition of liquid organic fertilizers that causes an increase in available nutrients in the soil, resulting in excess nutrients being absorbed by plants. It will disrupt the balance of nutrients that are absorbed so that it will suppress plant growth.

4. CONCLUSION

The dosage of Bioboost liquid organic fertilizer gave a very significant effect on the growth and yield of lettuce on Alfisol top soil planting media, where the concentration of B2 treatment (80 ml of bio boost fertilizer + 1 liter of water) resulted in variables growth and the highest yield, namely plant height 39.5 cm, some leaves 11, leaf area 91.3 cm, and wet weight 610, 4 gram.

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