



## Performance of Lettuce (*Lactuca sativa*) Grown under Ultisols Subsoil with Chicken Manure and Dolomite

Reza Junita Okta Viani, Merakati Handajaningsih\*, Eko Suprijono, and Marwanto

Department of Crop Production, Faculty of Agriculture, The University of Bengkulu, Bengkulu. Indonesia.

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### ABSTRACT

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\*Corresponding author:

E-mail: [merakati@unib.ac.id](mailto:merakati@unib.ac.id)

Lettuce is a horticultural plant with a short harvest time that is a popular vegetable choice for planting in polybags in urban areas. Planting media for cultivating plants in polybags vary widely. The use of nutrient-poor and acidic subsoil in Ultisols as a planting medium requires additional organic matter and lime that are suitable for the plants. This study evaluated the use of subsoil as a medium for growing lettuce by adding chicken manure and dolomite. The Completely Randomized Design was used, which consisted of two factors and 6 replications. The first factor was the dose of chicken manure consisting of: 0 ton/ Ha, 10 tons/ Ha (38g /polybag), 20 tons/ Ha (76g/ polybag), and 30 tons/ Ha (115g /polybag). The second factor was the dolomite dose, consisting of no dolomite, 1xAl-exch, and 2xAl-exch. A dose of 20 tons/ Ha of chicken manure combined with 1xAl-dd of dolomite increased the growth of plants. The treatment of chicken manure at 20 tons/ Ha showed growth and yield of lettuce that were as good as a treatment dose of 30 tons/ Ha. The highest fresh weight (123.05g) was obtained from 30 tons/ Ha-chicken manure treatment. The appropriate dose of dolomite for lettuce growth and yield was 1xAl-exch, which resulted in a plant fresh weight of 121.12 g. Subsoil is suitable to be used as a medium for planting lettuce in polybags by adding chicken manure or dolomite.

### INTRODUCTION

Lettuce plants (*Lactuca sativa* L.) are horticultural plants that belong to the Asteraceae (Compositae) family, have a short harvest time, and have very high economic value after cabbage, cauliflower, and broccoli. The prospect of market demand will continue to increase in line with increasing population, public education, income (Ikram et al., 2015), and welfare of the community in which the household income for freelance workers in 2022 was IDR. 1,392,000 and in 2023 it was IDR. 1,730,000 per month (Badan Pusat Statistik Indonesia, 2022; Badan Pusat Statistik Indonesia, 2023), and increasing public preference for lettuce.

The lettuce cultivation system has undergone many developments, for example, conventional systems in open fields, greenhouse production systems, container systems, and verticulture. Container systems such as pots and polybags for lettuce cultivation are increasingly being used by the community, especially with the development of urban agriculture. Plant cultivation in containers is generally possible using a mixture of planting media from various materials that have a high level of soil fertility, namely by combining topsoil, sandy soil, and organic materials (Astuti et al., 2018; Suhartati and Allo, 2022; ).

Finding fertile topsoil in an area like

Bengkulu City is not easy since this area is dominated by Ultisols, which are characterized by thin topsoil layers and poor fertility. Instead, people use the subsoil of Ultisols as planting media. Joniken (1984) reported that subsoil contained lower organic matter content, availability of phosphorus, and exchangeable Ca, Mg, K, and CEC compared to topsoil. The consequence is that subsoil must be incorporated into other materials to make it more favorable for plant growth and development.

Chicken manure is an organic fertilizer that can increase soil pH and C-organic content in the Ultisols (Atmaja et al., 2017). Chicken manure contains macro and micronutrients, including nitrogen, phosphorus, potassium, calcium, manganese, manganese, and copper. Apart from adding nutrients, chicken manure can also increase the number of microorganisms that decompose organic material to improve the physical, chemical, and biological properties of soil. The advantages of chicken manure in improving soil quality and horticultural plants have been proven by several studies (Amanullah et al., 2010; Zamzani et al., 2023) and by other food crops (Ning et al. 2022). The availability of nutrients in the soil to plants depending on the appropriateness of soil acidity.

Dolomite is an agricultural lime containing MgO and CaO, which are expected to increase soil pH and suppress exchangeable Al. Dolomite can improve soil chemical properties, reduce Al content or saturation, increase Ca and Mg content, and improve P availability on dry, acidic soil. Previous studies have shown the advantages of dolomite application to improve plant growth as well as yield on melon (Handajaningih et al., 2019), long beans (Nugroho et al. 2019), and shallot (Handajaningih et al., 2021). Lettuce is a sensitive plant to nutrients, so this research aimed to evaluate the lettuce response to the application of chicken manure and dolomite as an amendment of subsoil media.

The objective of this study was to evaluate the use of subsoil as a medium for growing lettuce by adding chicken manure and dolomite. This evaluation will provide valuable insights into sustainable agricultural practices

and offer practical solutions for improving soil health and vegetable productivity.

## MATERIALS AND METHOD

This research was conducted from November to December 2020 in Bengkulu City, Indonesia. The design of the research was a completely randomized design, which consisted of two factors and was repeated 6 (six) times. The first factor was the dose of chicken manure with 4 levels, namely: 0 tons/ Ha, 10 tons/ Ha, 20 tons/ Ha, and 30 tons/ Ha. The second factor was the dose of dolomite with 3 levels, namely: without dolomite, 1 x Al-exch, and 2 x Al-exch.

Lettuce seeds var. Grand Rapid was sown in seedling trays filled with soil and chicken manure at a ratio of 2:1(v/v). The seedling tray consisted of 150 holes in which each hole contained 12 cm<sup>3</sup> of medium. Chicken manure in the seedling medium ensured that the lettuce seedling grew well but not interfere the treatments. Sowing was performed 2 weeks before planting, placed under a shading area, and maintained by watering the seeds every day. Lettuce seedlings were transplanted into the experimental polybags after the emergence of 3 leaves.

The planting medium used was Ultisols subsoil taken from the experimental field in the City of Bengkulu. The planting medium was air-dried and then sieved using a 2-mm sieve. The soil medium was placed into 40 cm x 35 cm polybags after incorporating chicken manure and dolomite according to the treatments. The polybags were arranged with a distance of 25 cm between the polybags. There was 1 plant placed in each polybag. At the date of transplanting, the plant was fertilized with NPK fertilizer (16:16:16) at the rate of 0.16 g per polybag, which was 50% of the recommended dose. The lettuce plants were harvested 42 days after planting.

Data on plant growth and yield were collected, which included plant height, number of leaves, leaf greenness, leaf length, plant fresh and dry weight, root fresh and dry weight, stem fresh and dry weight, leaves fresh and dry weight, and shoot: root ratio. The obtained

observation data were analyzed using analysis of variance; mean separation was analyzed using Duncan's multiple range test.

## RESULTS AND DISCUSSION

In this research, the planting medium used was subsoil Ultisols. Pre-treatment soil analysis showed N = 0.17 %, P<sub>2</sub>O<sub>5</sub> = 10.17 ppm, K = 0.11 mg/100 g, C = 2.60 %, pH H<sub>2</sub>O = 4.50, and Al-exch = 2.70. The soil pH after the application of dolomite and chicken manure is presented in Table 1.

The data on the changes in pH media over 7 weeks indicated that the addition of dolomite solely into Ultisols subsoil increased the pH media compared with the control treatment, but there was no significant difference throughout the 6 weeks of the experiment. The characteristics of pH changes were detected after the addition of chicken manure into the subsoil media, in which the soil pH was increased 3 weeks after the application of chicken manure. These data reveal that chicken manure played an important role in improving subsoil quality. Munoz et al. (1990) reported that chicken manure has a high pH of 7.57 at fresh conditions, but the value depletes after 2 months to 6.45, which is in line with the decomposition period.

Table 1. The pH values of the media at different combinations of treatments

Treatment	pH value (week after application)					
	2	3	4	5	6	7
0 - 0	4.5	4.5	5.0	4.5	5.0	4.5
0 - 1	5.8	5.7	5.8	5.7	5.8	5.6
0 - 2	5.6	5.7	5.9	5.8	5.7	5.8
10 - 0	5.8	6.5	7.0	6.8	6.9	7.0
10 - 1	5.4	6.4	6.8	6.9	6.8	6.9
10 - 2	6.0	6.8	6.7	6.8	6.9	6.8
20 - 0	5.6	6.5	6.7	6.8	6.9	6.9
20 - 1	6.0	6.5	6.6	6.7	6.8	6.9
20 - 2	5.4	6.8	6.9	6.8	6.9	6.9
30 - 0	5.5	5.7	6.5	6.8	6.8	6.8
30 - 1	5.6	6.5	6.8	6.6	6.7	6.9
30 - 2	6.0	6.6	6.7	6.8	6.9	6.9

Note: Treatment was a combination of treatment of chicken manure with dolomite (ton/Ha - xAl.exch)

Duruigbo et al. (2007) revealed that 15 tons/Ha of chicken manure amended into Ultisols increased soil pH, whereas lower doses did not affect pH.

The computation using analysis of variance showed that the chicken manure dose interacted with the dolomite dose on leaf length and stem dry weight. The analysis of mean separation of leaf length is presented in Table 2.

Different doses of chicken manure from 10 tons/Ha to 30 tons/Ha without dolomite were capable of increasing the length of lettuce leaves. Meanwhile, the dose of 1xAl-exch or 2xAl-exch dolomite combined with various doses of chicken manure produced leaf length with no difference at each dose of chicken manure. A factor that supports plants to grow and reproduce optimally is the availability of sufficient nutrients in the soil. Chicken manure contains high percentages of nitrogen, phosphor, and potassium (Munoz et al., 1990) and is available in many forms (Pangaribuan et al., 2020). The interaction between dolomite and chicken manure increased the medium pH (Table 1) to the level at which nutrient availability was optimal.

Furthermore, by adding dolomite, 1xAl-exch or 2xAl-exch was found to produce greater leaf length than without dolomite. At a dose of 10 tons of chicken manure combined with various doses of dolomite, it was found that without the dolomite dose, the leaf length was lower than that of 1xAl-exch or 2xAl-exch.

Table 2. Length of lettuce leaves (cm) grown under different dolomite and doses of chicken manure

Chicken Manure (ton/Ha)	Dolomite		
	Control	1xAl-exch	2xAl-exch
0	9.81 b B	15.88 a A	15.18 a A
10	13.61 a B	17.06 a A	14.81 a AB
20	15.73 a A	17.13a A	15.50 a A
30	16.55 a B	17.85 a A	16.11 a B

Note: Numbers followed by the same lowercase letters in the same column or uppercase letter in the same row were not significantly different based on the 5% DMRT

Meanwhile, a dose of 20 tons of chicken manure combined with various doses of dolomite produced the same leaf length for each dolomite dose. At a dose of 30 tons of chicken manure combined with various doses of dolomite, 1xAl-exch produced greater leaf length than the no dose of dolomite or 2xAl-exch.

Table 3 shows that for treatment without dolomite combined with various doses of chicken manure, a dose without chicken manure resulted in a lower dry stem weight compared with other doses. The treatment of 1xAl-exch dolomite combined with various doses of chicken manure resulted in a dose of 10 or 20 tons of chicken manure, producing greater dry stem weight compared to giving no dose of chicken manure or a dose of 30 tons. This is in agreement with Dikinya and Mufwanzal (2010) statement that incorporating chicken manure influenced spinach yields due to better soil productivity. Meanwhile, a dose of 2xAl-exch dolomite combined with various doses of chicken manure produced the same dry stem weight for each dose of chicken manure. The research results of Handajaningsih et al. (2021) proved that dolomite at 1.5 x Al\_exch and 20 tons/Ha chicken manure can increase the formation of shallot bulbs. Both dolomite and chicken manure contain Ca and Mg, which can stimulate cell turgor and chlorophyll formation, leading to increased photosynthesis.

Furthermore, by providing various doses of

Table 3. Stem dry weight (grams) of lettuce treated with different concentrations of chicken manure and dolomite

Chicken manure (tons/Ha)	Dolomite		
	Control	1xAl-exch	2xAl-exch
0	0.52 b B	2.46 b A	3.05 a A
10	1.63 ab B	3.31 ab A	2.07 a AB
20	2.65 a B	4.24 a A	2.63 a B
30	2.40 a A	2.66 b A	3.43 a A

Note: Numbers followed by the same lowercase letters in the same column or uppercase letter in the same row were not significantly different based on the 5% DMRT

dolomite without chicken manure, we found that 1xAl-exch or 2xAl-exch resulted in greater stem dry weight than 0 dolomite. At a dose of 10 tons of chicken manure combined with various doses of dolomite, it was found that the dose without dolomite produced a lower stem dry weight compared to giving dolomite 1xAl-exch or 2xAl-exch. After treatment of 20 tons of chicken manure combined with various doses of dolomite, 1xAl-exch produced a greater dry stem weight than doses applied without dolomite or 2xAl-exch. Treatment with 30 tons of chicken manure combined with various doses of dolomite resulted in the same dry stem weight for each dolomite dose. This proves that chicken manure can help plant growth optimally as a provider of the macronutrients N, P, and K to increase plant growth, while dolomite provides a major nutrient of calcium (Ca) and magnesium (Mg) that can accelerate the division of meristem cells in plants. Providing organic materials combined with dolomite provides higher yields because the simultaneous effects of these two materials result in more optimal plant conditions.

The mean differences among doses of chicken manure on growth and yield are presented on Table 4. The number of leaves in 0 tons/Ha chicken manure (9.88) was not significantly different from treatment 10 tons/Ha (11.27) but was significantly different from treatments 20 tons/Ha (13.55) and 30 tons/Ha (14.11). In this observation variable, the highest number of leaves was obtained from treatment at 30 tons/Ha. This indicates that the more chicken manure is administered, the faster the plant growth will develop. The level of leaf greenness in treatment 0 tons/Ha (12.77) was not significantly different from treatment 10 tons/Ha (13.99) but was significantly different from treatments 20 tons/Ha (15.80) and 30 tons/Ha (15.75). This is because chicken manure contains the nutrient N, which functions to help the formation of chlorophyll, which affects photosynthesis, as proved by Rasool (2023). The relatively high N content of chicken manure can be used to meet the nutrient needs of lettuce.

The root volume in treatment 0 tons/Ha

Table 4. Growth and yield of lettuce plants treated with various concentrations of chicken manure

Variables	Dose of chicken manure (ton/Ha)			
	0	10	20	30
Numbers of leaves	9.88 c	11.27 bc	13.55 ab	14.11 a
Leaf greenness	12.77 b	13.99 ab	15.80 a	15.75 a
Root volume (cm <sup>3</sup> )	1.72 b	1.82 ab	1.88 ab	1.96 a
Plant fresh weight (g)	66.16 b	94.11 ab	111.83 a	123.05 a
Shoot fresh weight (g)	63.38 b	85.33 ab	111.05 a	115.72 a

Note: Numbers on the same row followed by the same letter indicate that they were not significantly different based on the 5% DMRT

(1.72 cm<sup>3</sup>) was not significantly different from treatment 10 tons/Ha (1.82 cm<sup>3</sup>) and treatment 20 (1.88 cm<sup>3</sup>) but was significantly different from treatment 30 tons/Ha (1.96 cm<sup>3</sup>). The highest root volume obtained from treatment at 30 tons/Ha indicated that the organic material provided improved the drainage system. Organic fertilizer can physically improve soil pores and soil aggregates to improve drainage and soil aeration and improve the ability of roots to absorb nutrients.

The plant and shoot fresh weights at 20 tons/Ha (111.83 grams and 111.05 grams) were significantly higher than those at zero poultry manure treatment (66.16 grams and 63.38 grams respectively). The plant and shoot fresh weights reached their highest values at 30 tons/Ha. Organic material, apart from improving soil conditions, was also able to supply the nutrients needed by plants, accelerating plant maturation. Purba et al. (2019) revealed that the application of 30 tons/Ha of manure could increase the production of Chinese cabbage plants. Applying manure can improve soil structures, such as porosity and soil aeration, and increase the availability of nutrients and plant growth. This study highlighted that chicken manure doses did not affect plant dry weight as well as shoot dry weight. The fact that the fresh weights of those variables were significantly different implied that chicken manure improved water absorption from roots to shoot and plant leaves.

The results of the data analysis presented in Table 5 showed that application a dose of 1xAl-exch dolomite increased the growth and yield of lettuce. Dolomite can improve the pH of the soil. Plant growth and development are influ-

enced by soil acidity. The subsoil pH changed from 4.5 to 5.8 – 5.9 after the application of dolomite and chicken manure. Most plant nutrients are available in the pH range of 5.5 – 6.0. In addition, the performance of roots to uptake nutrients was also higher. Adversely, at high soil pH, minor nutrients are unavailable (Ferrarezi et al., 2022).

The role of dolomite in increasing soil pH was shown in research conducted by Pamungkas et al. (2017), in which the acidic properties of Ultisols (pH 4.8) and peat (pH 3.6) were changed to 6.5 and 6.7 at a dolomite dose of 4 tons/Ha and affected the dry biomass of Bogor groundnut. The 1xAl-exch treatment showed that the growth and yield of lettuce plants were more optimal than those of 2xAl-exch because the higher dose of lime inhibited the growth and yield of lettuce plants. Fertilizing plants at excessively high or exceeding optimal limits can decrease yield. The plant fresh weight ratio of shoots: roots and the dry weight ratio of shoots: roots showed no significantly different results for both chicken manure doses and dolomite doses. The use of chicken manure at the wet weight ratio of shoots: roots gave the highest yield, 2.03, while the dry weight ratio of shoots: roots is 1.81.

## CONCLUSIONS

Providing a dose of 10 tons/Ha of chicken manure combined with 1xAl-exch dolomite increased the growth of lettuce plants. The appropriate chicken manure dose for lettuce growth and yield was 10 tons/Ha. The appropriate dose of dolomite for lettuce growth and yield is 1xAl-exch. Chicken manure alone or in combination with dolomite can increase soil pH.

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