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Growth response of lettuce plants to the application of NASA liquid organic fertilizer and cow manure

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ABSTRACT

Lettuce (*Lactuca sativa L.*) was a leafy vegetable that has high economic value in Indonesia and provides health benefits to consumers. The use of organic fertilizers is deemed more optimal than inorganic fertilisers due to the potential of inorganic fertilizers to cause soil damage and environmental pollution through chemical residues and land productivity reduction. The study aimed to evaluate the effects of using NASA liquid organic fertilizer and cow manure on the growth and yield of lettuce plants. The study used a Randomised Block Factorial Design with two factors: cow manure with four treatment levels and NASA liquid organic fertiliser with three treatment levels. The results showed that chicken manure had a significant effect on plant height, leaf area, leaf dry weight, and stem fresh weight at 28 days after planting (DAT), while NASA liquid organic fertilizer had no significant effect on all parameters except plant height at 7 DAT. Higher doses of chicken manure (S2 and S3) contributed to the increase in dry weight and fresh weight of leaves. Application of NASA liquid organic fertilizer at a dose of 4 ml/L (N2) showed a better response in supporting plant vigor than others. In addition, the highest plant fresh weight was obtained in the combination of S3 and N2 treatments, indicating a synergistic effect between the two types of organic fertilizers. High a dose of chicken manure (S3 = 900 g) can negatively affect growth by lowering soil pH and causing too acidic conditions that are not optimal for plants.

Keywords: cow manure fertilizer, *Lactuca sativa* L., POC NASA, plant growth, yield components

INTRODUCTION

Lettuce (*Lactuca sativa L.*) is a seasonal plant that could be grown in the highlands or lowlands. Lettuce (*L. sativa L.*) had the role of a source of vitamins and minerals. Lettuce development had the potential to improve nutrition and farmers' income to be used as a business (Lamawulo et al., 2017). Increasing horticultural production in Indonesia, especially lettuce nutrition (*L. sativa L.*) is focused on increasing yields and improving maintenance through fertilization (Utami et al., 2021). Fertilization doses can improve the quality of crop yields, along with improved growing media (Hasniar et al., 2022). Fertilization was needed to ensure optimal plant growth (Kurniawan & Abdul, 2023), considering that sometimes nutrients in the soil are insufficient. In lettuce fertilization, the dosage, timing, and method of fertilization are key factors to increase yield.

To increase its production by utilizing liquid organic fertilizer. Fertilizer from a mixture of several ingredients that provide positive benefits for plant growth (Hanipah et al., 2021). Farmers use POC keong mas and Urea fertilizer combined as a source of Nitrogen which had a role in stimulating growth in stems and leaves (Asroh & Novriani, 2019). The use of organic fertilizers can be a solution to reduce dependence on excessive inorganic fertilizers (Putri et al., 2013). (Kebang et al., 2019) stated that farmers often rely on chemicals, especially urea, in treating lettuce plants because the high nitrogen content

in urea supports plant leaf growth. The addition of NPK fertilizer to enrich nutrients for optimal growth. This fertilizer is expected to provide ease of application in the field and increase the availability of soil nutrients (Elfaziarni & Herlina, 2018). Lettuce production can be increased through fertilization, including the use of organic fertilizers such as cow manure. Cow manure contains nutrients and organic matter to improve soil properties. The addition of Nasa organic liquid fertilizer can also increase the availability of nutrients for lettuce plants (Thoriq et al., 2022). Nasa liquid organic fertilizer, which is an important innovation in the world of agriculture, had proven to be able to meet the nutritional needs of plants. In research, Nasa liquid organic fertilizer had been shown to include macro and micronutrients, growth regulators, and soil microorganisms.

The advantage of NASA POC lies in its ability to support the growth of various types of plants, including vegetables, fruits, and ornamental plants (Supyandi & Rahmi, 2023). The content contained in the concentration of NASA POC helps the process of improving soil friability and contains growth hormones that stimulate plant formation (Husna et al., 2023). The use of cow dung as a plant fertilizer is highly recommended because it had minimal side effects and is free from chemicals that can damage soil structure. Cow dung is rich in nutrients such as Zn, Cu, Mo, Co, Ca, Mg, and Si, which can increase the cation exchange capacity of the soil. This helps reduce the influence of toxic metal ions and inhibits the provision of nutrients such as Al, Fe, and Mn to plants (Samoal et al., 2018). Without cow manure, plants experience a lack of vital nutrients for biomolecule synthesis. As a result, plant growth is stunted and metabolism is disrupted (Abror & Prasetyo, 2018). The purpose of this research was to provide an in-depth understanding of the interaction of the two types of fertilizers and obtain optimum results at various doses of nasa liquid organic fertilizer and cow manure on the growth and production of lettuce (*Lactuca sativa L.*).

MATERIALS AND METHODS

This research was conducted in September-October 2022 in Kertapati District, Palembang, South Sumatra. The tools used in this research: 1) Stationery, 2) Measurement Tools, 3) Hoe, 4) Bucket, 5) Watering can, 6) Camera. 7) Leaf area meter, 8) Analytical balance, 9) Polybag volume of 10 kg, 10) SPAD, 11) Scales and 12) Seedling tray. While the materials used in this study: 1) Water, 2) Lettuce seeds, 3) Label paper, 4) Cow manure, 5) Nasa liquid organic fertiliser and 6) Soil.

Research Implementation

Seed Sowing

Seed sowing was performed on a seedling tray media, before seed sowing, the seeds were first soaked for about 1 hour to stimulate root growth to facilitate the germination process.

Planting Media Preparation

Planting media preparation uses topsoil and cow manure that has been filtered from stones and other materials. The application of cow manure was carried out according to the treatment of the planting media to be used. The doses of cow manure were: control (S0) with a ratio of 2:1 between cow manure and soil, S1 with 300 g/polybag of cow manure, S2 with 600 g/polybag of cow manure, and S3 with 900 g/polybag of cow manure. After that, the cow manure was stirred and mixed with the soil evenly before being put into the polybag. In this study (Sanda & Hasnelly, 2023) showed that the best treatment for lettuce planting involved the use of POC and the provision of 300 g of cow manure per polybag. The results of the study (Setiono & Azwarta, 2020) showed that the application of cow manure 600 g / hole had a significant effect on plant height, stem diameter, number of leaves and net fresh weight in corn plants.

Planting

The lettuce seedlings used were 2-3 weeks old or have 4-5 leaves. Planting was done by moving the lettuce seedlings one by one from the seedling tray, then inserting the lettuce seedlings into the planting holes and covering them with planting media.

Fertilization

Nasa liquid organic fertilizer was applied 4 times (N1, N2, N3) with concentrations of 2

ml/L, 4 ml/L, and 6 ml/L of water, watered at the age of 6, 12, 18, and 24 DAT. In this study (Sarido & Junia, 2017) the best results of pakcoy plants were obtained at a concentration of Nasa liquid organic fertilizer of 6 cc/L of water (P3), which produced 11.09 leaves and a wet weight of 60.58 grams. The use of a combination of Nasa liquid organic fertilizer at a dose of 2 ml/L of water with goat manure as much as 1.5 kg per polybag showed significance, especially in achieving the highest stem diameter growth (Wahyudi et al., 2020).

Maintenance

Maintenance was carried out by watering in the morning and evening according to field conditions. Weed control was done manually by pulling weeds around the plants. Replanting was done a maximum of 2 weeks after planting to maintain the consistency of plant growth. Pest and disease control was carried out using pesticides and insecticides, adjusted to the level of attack and could also be done manually by cutting the affected parts.

Harvest

Harvesting was done when the lettuce was 30-40 DAT, characterized by the lower leaves touching the ground and the shape of the leaf blade was maximum.

Observation Parameters

Plant height (cm), Number of leaves (blade), Leaf area (cm2), Leaf fresh weight (g), Leaf dry weight (g), Leaf greenness, Stem fresh weight (g), Stem dry weight (g), Root length (cm), Root fresh weight (g), Root dry weight (g).

Research Methodology

The method used in this research was the Randomized Group Factorial Design method consisting of 2 factors, namely the first factor of cow manure consisting of 4 levels, and the second factor was NASA liquid organic fertilizer consisting of 3 levels. With 3 replicates then each replicate has 3 plants. So there were 108 treatment units. The following were the details of the treatments used in the study, namely: First factor, namely: the dose of Cow Manure (S). S0 = Control, S1 = Dose of Cow Manure 300 g/polybag, S2 = Dose of Cow Manure 600 g/polybag, S3 = Dose of Cow Manure 900 g/polybag. The second factor was the dosage of NASA Liquid Organic Fertilizer (N). N1 = Dose of NASA Liquid Organic Fertilizer 2 ml/ L, N2 = Dose of NASA Liquid Organic Fertilizer 4 ml/ L, N3 = Dose of NASA Liquid Organic Fertilizer 6 ml/L.

The factorial randomized block design method was chosen because it allowed the evaluation of the effects of each material separately and their combination. In the study (Okalia et al., 2021) the impact of biochar and liquid organic fertilizer from rice washing water on the growth and production of lettuce (*Lactuca sativa L.*) was using the factorial randomized block design method so that the results of the study could provide more comprehensive information related to increasing lettuce growth and production.

Data Analysis

Data obtained from the results were analyzed using analysis of variance (ANOVA). If there was a significant difference, it will be continued with the east significant difference test at the 5% level.

RESULTS

Based on the analysis of variance, cow manure treatment (S) was significant on plant height 28 DAT, leaf area, leaf dry weight, and stem fresh weight, and highly significant on plant height 21 DAT, leaf number 28 DAT, and leaf fresh weight. Meanwhile, Nasa liquid organic fertilizer (N) only had a very significant effect on plant height 7 DAT, without significant effects on other variables. There was no interaction between cow manure and Nasa liquid organic fertilizer (SxN) on all parameters, except the fresh weight of lettuce plant roots (Table 1).

Plant Height (cm)

In the analysis of variance, it was revealed that NASA Liquid Organic Fertilizer only had a significant impact on plant height at 7 DAT, with the highest value seen in treatment N1 = 2 ml/L, reaching an average of 21.25cm (Figure 1). Cow manure, although it did not have a significant effect at 7 DAT and 14 DAT, had a very significant impact on plant height at 21

DAT and significantly influenced at 28 DAT, with the highest average in the S2 = 600g cow manure treatment, reaching 21.46 cm (Figure 1).

Number of Leaves

The results of the analysis of variance showed that NASA Liquid Organic Fertilizer did not have a significant impact on the number of leaves, with the highest value in the N1 = 2 ml/L treatment, reaching 13.11 strands (Figure 2). In contrast, cow manure had a very significant impact on the number of leaves at 28 DAT, with the highest mean value in the S1 = 300g cow manure treatment, which was 14.52 strands (Figure 2).

Leaf Area (cm2)

Based on the least significant difference test , there were significant differences between the treatments of cow manure and NASA Liquid Organic Fertilizer in each treatment. Treatments S0, S3, and S1 showed significant differences, while S2 and S1 were not significantly different. On the NASA Liquid Organic Fertilizer side, there was no significant difference in each treatment.

Leaf Fresh Weight, Stem Fresh Weight, Root Fresh Weight (g)

From the analysis of variance, it was revealed that the treatment of cow manure (S) had a very significant impact on the fresh weight of leaves and stems, and insignificant on the fresh weight of roots. In contrast, NASA Liquid Organic Fertilizer (N) treatment had no significant effect on all parameters (Table 2). There was an interaction between cow manure and NASA Liquid Organic Fertilizer (SxN) on root fresh weight.

In the least significant difference (LSD) test further test at the 5% significance level, the NASA Liquid Organic Fertilizer (N) treatment did not show significant differences in the fresh weight of leaves, stems, and roots. However, in the cow manure (S) treatment, significant differences were observed in leaf fresh weight between S0 and S2, and in stem fresh weight between S2 and S3. However, there was no significant difference between S0 and S2 for leaf fresh weight, and between S0 and S2 for stem fresh weight. Root fresh weight showed no significant difference in each treatment (Table 3).

Table 1. Results of analysis of variance of the effect of cow manure (S) and Nasa liquid organic fertilizer (N) on all observed variables

Parameters	S	N	S x N	KK(%)
Plant Height 7 DAT	2.88 tn	6.03**	1.26 tn	7.13
Plant Height 14 DAT	1.66 tn	2.56 tn	0.58 tn	8.95
Plant Height 21 DAT	7.64**	4.98 tn	0.91 tn	6.13
Plant Height 28 DAT	3.82*	1.92 tn	1.14 tn	10.55
Number of Leaves 7 DAT	1.47 tn	0.25 tn	2.01 tn	10.28
Number of Leaves 14 DAT	1.28 tn	2.11 tn	0.73 tn	7.77
Number of Leaves 21 DAT	1.79 tn	0.06 tn	0.99 tn	10.34
Number of Leaves 28 DAT	5.90**	1.05 tn	2.35 tn	14.83
Leaf Area	3.92*	0.59 tn	0.59 tn	44.51
Leaf Fresh Weight	5.86**	2.03 tn	0.76 tn	31.43
Leaf Dry Weight	3.33*	1.81 tn	1.30 tn	35.33
Leaf Greenness	1.29 tn	0.27 tn	0.93 tn	34.53
Stem Fresh Weight	3.20*	0.10 tn	0.83 tn	82.30
Stem Dry Weight	0.37 tn	1.16 tn	1.62 tn	122.21
Root Length	2.57 tn	0.07 tn	1.00 tn	13.91
Root Fresh Weight	1.06 tn	0.68 tn	2.84*	29.82
Root Dry Weight	2.11 tn	0.32 tn	1.14 tn	38.99
F Table 5%	3.04	5.14	2.54	
F Table 1%	4.81	5.71	3.75	

Note: KK = coefficient of variation. N = Nasa liquid organic fertilizer. S = cow manure. * = real effect. ** = very real effect. tn = no real effect.

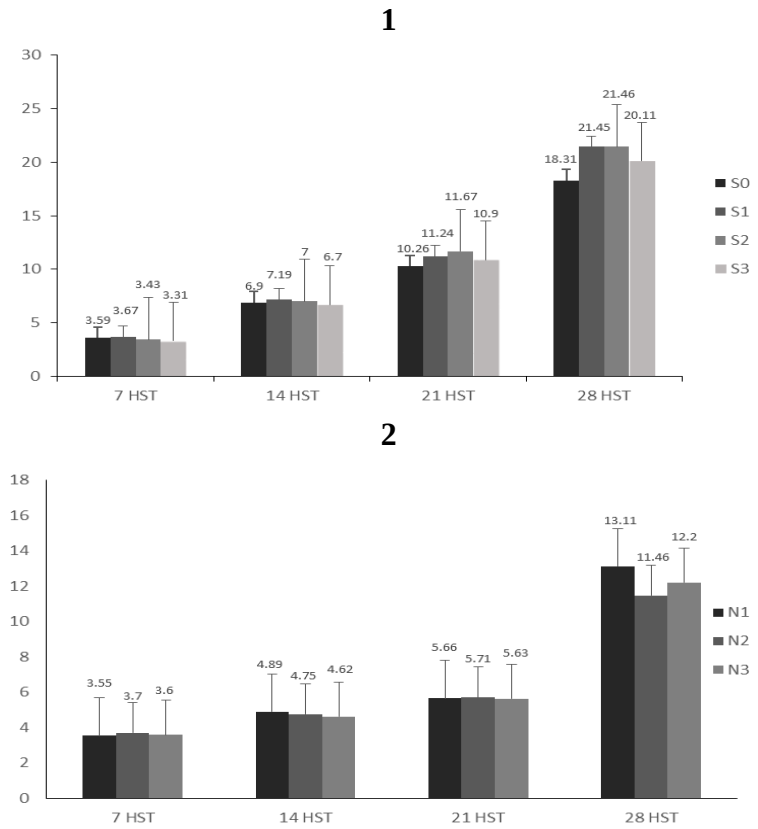

Figure 1. Average plant height per week with various doses of Nasa liquid organic fertilizer (1) and cow manure (2)

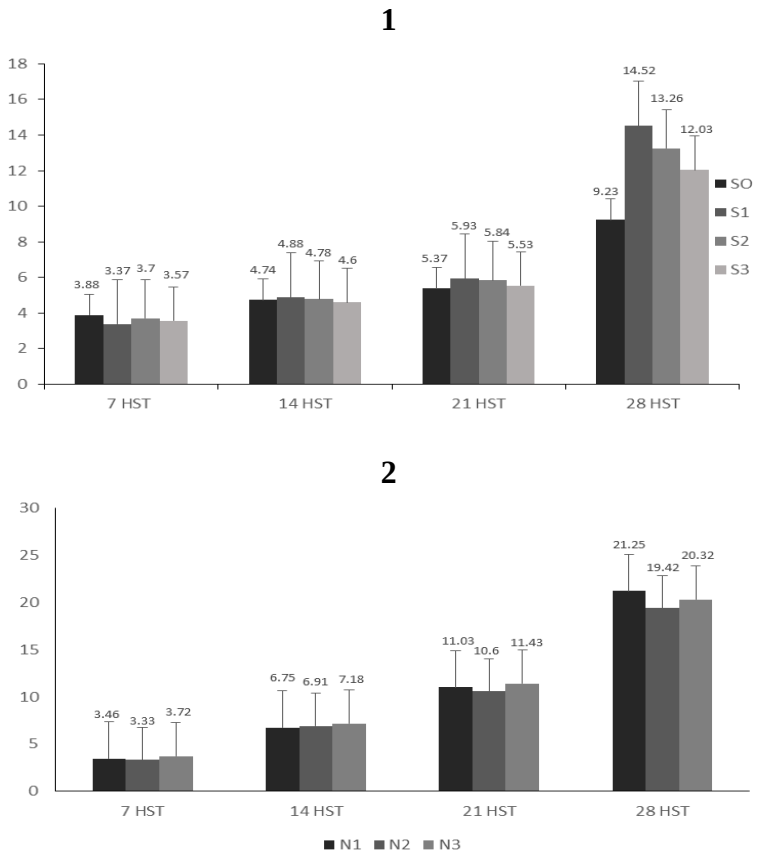

Figure 2. Average number of leaves per week with various doses of cow manure (1) and Nasa liquid organic fertilizer

Table 2. 5% least significant difference test results diameter of leaf area of lettuce plants

Fertilizer Dosage	Leaf Area
S0	955.55 a
S1	1177.99 b
S2	1331.93 b
S3	1383.74 a
N1	1231.68 a
N2	1140.27 a
N3	1264.96 a
least significant difference test 0.05	367.63

Note: Numbers followed by the same letter indicate the results were not significantly different in the 5% least significant difference test

Table 3. Results of 5% least significant difference test of fresh weight diameter per lettuce plant (g/plant)

Fertilizer Dosage	Fresh Weight		
	Leaf	Stem	Root
S0	36.62 a	25.80 a	2.49 a
S1	47.13 ab	56.00 ab	3.06 a
S2	52.98 b	39.19 a	3.13 a
S3	54.47 b	31.45 b	2.49 a
N1	49.94 a	34.17 a	3.49 a
N2	43.04 a	35.80 a	3.13 a
N3	50.42 a	36.86 a	3.77 a
LSD 0.05	11.24	15.88	0.78

Note: Numbers followed by the same letter indicate the results were not significantly different in the 5% least significant difference test

Leaf Dry Weight, Stem Dry Weight, Root Dry Weight (g)

From the analysis of variance, it could be seen that the treatment of cow manure and NASA Liquid Organic Fertilizer does not significantly affect the dry weight of stems and roots, but had a significant impact on leaf dry weight. The 5% LSD level test showed no significant difference in the NASA Liquid Organic Fertilizer treatment on the dry weight of leaves, stems, and roots. However, the cow manure treatment showed significant differences, especially in the fresh weight of leaves between S1 and S2, while S3 and S2 were not significantly different. There was no significant difference in the dry weight of stems and roots in the cow manure treatment (Table 4).

Table 4. Results of 5% least significant difference test of diameter dry weight per lettuce plant

Fertilizer Dosage	Dry Weigh		
	Leaf	Stem	Root
S0	2.73 a	2.24 a	0.36 a
S1	3.40 a	1.72 a	0.34 a
S2	4.07 b	1.86 a	1.46 a
S3	4.11 b	1.63 a	0.34 a
N1	3.49 a	2.33 a	0.40 a
N2	3.21 a	1.54 a	0.37 a
N3	4.03 a	1.72 a	0.36 a
LSD 0.05	0.92	1.01	0.78

Note: Numbers followed by the same letter indicate the results were not significantly different in the 5% least significant difference test

Leaf Greenness Level

Based on the analysis of variance, it was revealed that the treatment of cow manure and NASA Liquid Organic Fertilizer did not have a significant effect on the greenness of the leaves. However, the cow manure treatment reached the highest value at S1=300g, with an average of 27.41, while the NASA Liquid Organic Fertilizer treatment reached the highest value at N1=2 ml/L, with an average of 25.27 (Figure 3).

Root Length (cm)

Based on the analysis of variance, cow manure treatment (S) and Nasa liquid organic fertilizer treatment (N) did not significantly affect the root length parameter. However, the treatment of cow manure has the highest value in the S2 = 600g cow manure treatment, which is an average of 14.72 cm. The Nasa liquid organic fertilizer treatment has the highest value with the N3 = 6 ml/L treatment, which is an average of 13.72 cm.

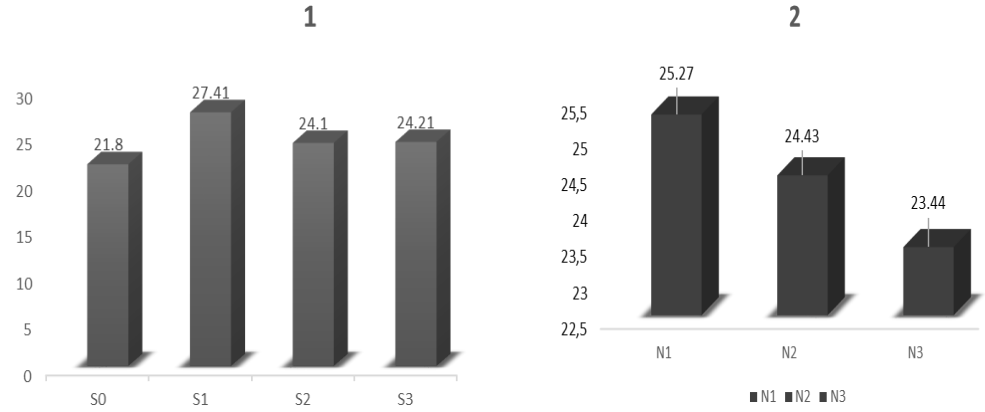

Figure 3. Average greenness of leaves with various doses of cow manure (1) and Nasa liquid organic fertilizer (2)

DISCUSSION

Analysis of variance showed that Nasa liquid organic fertilizer had a very significant effect on plant height, treatment N1 = 2 ml/L showed the highest growth with an average of 63.77 cm. Similarly, the results of the research (Lisdayani et al., 2019) state that the provision of liquid organic fertilizer has a significant effect on plant height, the provision of liquid organic fertilizer at a concentration of 2 ml/L of water is considered sufficient for pakcoy plants to increase growth activity. The dose and content of N elements in Nasa liquid organic fertilizer are considered adequate for the growth and production of lettuce plants, in accordance with the findings of (Syufrin et al., 2011) which suggests that lower doses give good results and are equivalent to higher doses. However, the application of cow manure is significant at 21 and 28 DAT plant height, this positive impact occurs because cow manure organic matter increases soil fertility physically, chemically, and biologically. The nitrogen content in cow manure supports plant growth by stimulating cell division, especially plant-length growth (Sriyanto et al., 2015).

Analysis of variance on the number of leaves showed that Nasa liquid organic fertilizer had the highest mean value at N3 = 6 ml/L with 36.62 cm at harvest time. A higher application of liquid organic fertilizer increases the availability of nutrients and can be absorbed by plants and used for metabolic processes to support the growth of new leaves, and increase the number of leaves on lettuce plants. This finding is consistent with previous research (Sarjana, 2007) and resulted in a significant increase at 21-28 DAT in the treatment. The results of the analysis of variance showed that cow manure had a significant effect on leaf area. According to (Dinariani et al., 2014), essential elements in cow manure accelerate growth, increase in area, and number of leaves. This accelerates photosynthesis, and increases the formation of carbohydrates as food reserves, and impacts the value of the area index. Leaf area is strongly influenced by chlorophyll activity where leaf growth expands along with more chlorophyll content. Cattle manure, particularly nitrogen elements, stimulates chlorophyll formation in leaves (Rahim et al., 2015). The results of variance showed that the combination of cow manure and nasa liquid organic fertilizer had a significant effect on root fresh weight. Following the statement (Elidar, 2018) POC Nasa contains auxins, gibberellins, and cytokinins, growth stimulating substances that play a role in chlorophyll formation, root growth and regeneration, increasing root retention, nutrient absorption efficiency, and reducing nutrient loss. Similarly, manure has the advantage of improving soil physical properties, such as permeability, porosity, structure, water-holding capacity, and soil cations. The ability of plants to extract water is influenced by root growth, which supports overall plant adaptation (Evanita et al., 2014).

Analysis of variance of lettuce fresh weight showed a significant effect of cow manure application. Related research (Gole et al., 2019) shows that higher doses of cow manure contributes to increased yields, following the concept that organic fertilizers are more needed for plants that consume their leaf parts during their growth, the response of plants to fertilizers

depends on the right dose, time, and method of application. Cow manure, as an organic fertilizer, provides macro and micronutrients that support plant needs. It increases the interception of sunlight by the leaves, amplifying vital photosynthates. This photosynthate-triggered metabolic process enhances root, stem, and leaf growth, positively affecting plant growth and yield (Febriyanto, 2023). Fresh weight reflects the accumulated yield of all vegetative organs of the plant, where optimal growth results in high fresh weight due to the water content in plant cells (Marlina et al., 2015).

The results of the 5% LSD test showed that the POC Nasa treatment had no significant effect on the parameters of root fresh weight, leaf fresh weight and stem fresh weight. However, the N3 = 6 ml/L treatment produced the highest value of lettuce fresh weight. This is due to not getting enough nutrient intake. According to (Neli et al., 2016) Fertilizer management often causes loss of nitrogen elements, and the application of POC NASA at low doses does not produce optimal growth because the availability of nutrients that are lacking can inhibit plant growth and development, and affect plant productivity. Plant dry weight reflects nutritional status and determines plant growth and development, closely related to nutrient availability (Sitorus et al., 2014). Cow manure, especially at high doses such as S3=9 g, has a positive effect on lettuce dry weight. However, high doses of manure especially at S3 can be detrimental to growth by affecting the pH of the growing medium. The addition of excessive manure can cause a drastic decrease in pH, making the soil very acidic and not conducive to plant growth (Wasis & Fitriani, 2022).

CONCLUSSION

Based on the results of the study, it can be concluded that the use of cow manure and Nasa liquid organic fertilizer shows that S2 (cow manure 600 grams) and N1 (Nasa liquid organic fertilizer 2 ml/L) are the best results in increasing plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, root length, root fresh weight of lettuce plants.

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