

Optimizing Romaine Lettuce Plant Yield and Growth by Providing Liquid Organic Fertilizer from Rabbit Urine

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Abstract. This study aims to determine the effect of liquid organic fertilizer (POC) made from rabbit urine as a source of N, P, and K nutrients and the interval of POC administration on the growth and yield of romaine lettuce plants. The study was conducted in the experimental field of Muhammadiyah University of Sidoarjo, Modong Village, Tulangan District, using a Randomized Block Design (RAK) with 9 treatments and 3 replications (27 experimental units). The first factor was the concentration of rabbit urine POC (20 ml/L, 40 ml/L, and 60 ml/L), and the second factor was the administration interval (once every 2, 4, and 6 days). The parameters observed included plant height, number of leaves, root length, wet weight, and dry weight. The results showed that the 60 ml/L treatment with an interval of once every 4 days (K312) gave the best results in the number of leaves, wet weight, and dry weight. However, plant height and root length showed no significant results in the treatment interaction.

Keywords: foliar fertilizer, atonic, pepper

1 Introduction

Indonesia is a country with a wide variety of plant species, one of which is lettuce. Lettuce is a plant of the Asteraceae family and has several types that are grouped into four groups, namely head lettuce, cos lettuce or romaine lettuce, cutting lettuce or leaf lettuce, and asparagus lettuce or stem lettuce [1].

Romaine lettuce (*Lactuca sativa* L.), also known as Roman lettuce or cos lettuce, has many benefits, including its use as food and its medicinal properties [2]. Lettuce plants are classified as horticultural crops, which are potential crops with high market demand and economic value. The nutrients contained in romaine lettuce are very beneficial in terms of public nutrition. Based on its nutritional content, romaine lettuce is a major source of calories, minerals, and vitamins [3] and contains plant chemicals such as carotenoids, anthocyanins, and phenolics [4].

To increase crop production, balanced fertilization is required. Fertilizer is one of the main sources of nutrients provided to plants. The provision of nutrients for plants can be done by adding fertilizers in general. There are two types of fertilizers commonly used, namely inorganic fertilizers and organic fertilizers [5]. However, in the cultivation process, there are many obstacles related to cultivation soil problems, one of which is the decline of organic matter in the soil. To reduce soil fertility decline and increase sustainable productivity, it is necessary to utilize adequate organic fertilizers in terms of , quality, and continuity [6]. Organic fertilizers are now widely known to the public and have even become a government program to increase soil fertility and crop production [7].

Organic fertilizers play an important role in ensuring the sustainable use of agricultural land. Organic fertilizers can ensure soil fertility, increase the population of microorganisms, and increase water absorption and retention [8]. Organic fertilizers can be in solid or liquid form. Solid organic fertilizers are known as compost or manure, while liquid organic fertilizers are known as Liquid Organic Fertilizers (POC) [9]. Liquid organic fertilizer is a solution from the decomposition of organic materials derived from plant residues, agro-industrial waste, and animal manure [10]. Liquid organic fertilizer (POC) is now widely produced, and one of the types used in this study is rabbit urine POC. Liquid organic fertilizer derived from rabbit urine has a fairly high nutrient content, namely N 4%; P₂O₅ 2.8%; and K₂O 1.2% [11].

2 Method

This study was conducted on the research land of the Agrotechnology Study Program, Muhammadiyah University Sidoarjo, in Modong Village, Tulangan District, Sidoarjo Regency. It was carried out over a period of

This study used a Randomized Block Design (RBD) method. This study was a factorial experiment consisting of 2 factors [12] [13]. The first factor was the concentration of rabbit urine POC, and the second factor was the interval of rabbit urine POC application. The rabbit urine POC concentration consisted of K1 = 20 ml/l water, K2 = 40 ml/water, K3 = 60 ml/l water. The rabbit urine POC administration interval consists of 11 = once every 2 days, 12 = once every 4 days, 13 = once every 6 days. Thus, there are 12 treatment combinations, each of which is repeated three times, resulting in a total of 36 experimental units.

The tools used in this study included a hoe, shovel, bucket, polybag, marker board, watering can, barrel, ruler, writing instruments, cell phone camera, and laboratory equipment for analyzing the dry weight of plants. The materials used in this study included rabbit urine POC.

The method for making rabbit urine POC is as follows: Put rabbit urine in a 5-liter jerry can, mix it with EM4 and molasses/sugar cane juice/brown sugar, shake the jerry can for 2-3 minutes so that the mixture becomes homogeneous, and let it sit in a shaded room for 7-8 days until fermentation is complete. Occasionally open the jerry can to release the gas. Fermentation is successful if after 7-8 days, there is no more odor.

3 Results and Discussion

3.1 Number of Leaves

Based on the variance analysis obtained, the treatment of liquid organic rabbit urine fertilizer dosage and time interval affects the growth of romaine lettuce plants in terms of the number of leaves. To see the differences, further tests were conducted using 5% and 1% BNJ.

Table 1. Average treatment of time intervals and doses of liquid rabbit urine fertilizer on the number of leaves

Treatment	Plant age									
	7 days after sowing		14 days after sowing		21 days after sowing		28 days		35 days	
K1I1	4.33	ab	6.7	ab	9.33	ab	14.0	ab	17.33	ab
K1I2	3.67	a	6.0	ab	7.33	ab	9.3	a	13.00	a
K1I3	3.33	a	5.0	a	6.67	a	10.3	a	11.33	a
K2I1	4.67	ab	7.0	ab	9.00	ab	10.0	a	1:00	a
K2I2	4.33	ab	6.3	ab	7.33	ab	11.0	a	13.67	a
K2I3	3.67	a	5.3	a	6.33	a	8.3	a	11.00	a
K3I1	4:00	ab	6.0	ab	8.00	ab	12.3	a	14.33	ab
K3I2	6.33	b	8.3	b	11.7	b	19.0	b	21.33	b
K3I3	4.67	ab	6.7	ab	8.00	ab	10.7	a	13:00	a
BNJ	2.43		2.57		1.50		6.13		7.42	

Note: Different numbers in the same column indicate significant differences.

The results of the study show that the concentration of POC in rabbit urine and the watering interval are significantly different, with the highest results observed in the K3I2 treatment with a concentration of 60 ml/l of water and a watering interval of once every 4 days.

3.2 Plant Height (cm)

Based on the analysis of variance obtained, the treatment of rabbit urine liquid organic fertilizer dosage and time interval affected the growth of romaine lettuce plants in terms of plant height. To determine the differences, further tests were conducted using BNJ 5% and 1%.

Table 2. Average Treatment of Watering Interval and Liquid Rabbit Urine Organic Fertilizer Dosage on Plant Height

Treatment	Plant Age				
	7 days after sowing	14 days	21 days	28 days	35 days after sowing
Concentration					
K1	11.33 a	16.50 a	22.2 a	29 a	25.60
K2	11.00 a	16.40 a	24.8 b	29.4 a	27.12
K3	15.00 b	21:57 b	28.6 c	35.8 b	32.22
BNJ	0.99	1.42	0.92	1.66	tn
Interval					
I1	15:47 c	20.77 c	18.12	19.4	18.78
I2	14.07 b	18.6 b	16.33	17.5	16.90
I3	11.67 a	15.1 a	13.38	14.2	13.81
BNJ	1.37	1.42	tn	tn	tn

Note: Identical numbers in the same column indicate no significant difference, tn = not significant.

The research results indicate that the interaction between the two treatments showed no significant effect on plant height, however, each treatment showed significant differences in plant height within each treatment, with the highest data at the rabbit urine POC concentration in treatment K3 at a dose of 60 ml/l water and the highest data at the time interval in treatment I1 with a watering interval of every 2 days. However, at 28 to 35 days after sowing, there was no significant effect on all treatments at the time interval.

3.3 Root Length

Based on the analysis of variance obtained, the treatment of rabbit urine liquid organic fertilizer dosage and watering interval affected the growth of romaine lettuce plants in terms of the root length observation parameter. To see the differences, further tests were conducted using BNJ 5% and 1%.

Table 3. Average Treatment of Watering Interval and Liquid Rabbit Urine Organic Fertilizer Dosage on Root Length

Treatment	Root Length
Concentration	
K1	18.80
K2	17.97
K3	22.23
BNJ	tn
Interval	
I1	21.10
I2	20.07
I3	17.83
BNJ	tn

Note: Identical numbers in the same column indicate no significant difference; tn = not significant.

The results of the study indicate that the treatment of rabbit urine dosage and time interval showed no significant difference in root length.

3.4 Fresh Weight

Based on the analysis of variance obtained, the treatment of rabbit urine liquid organic fertilizer dose and time interval affects the growth of romaine lettuce plants in terms of wet weight. To determine the differences, further tests were conducted at 5% and 1% BNJ.

Table 4. Average Treatment of Time Interval and Rabbit Urine Liquid Organic Fertilizer Dose on Wet Weight

Treatment	Mean	Notation
K1I1	46.13	ab
K1I2	20.90	a
K1I3	17.37	a
K2I1	28.13	a
K2I2	39.33	ab
K2I3	19.80	a
K3I1	36.00	ab
K3I2	66.73	b
K3I3	20.53	a
BNJ	37.02	

Note: Identical numbers in the same column indicate no significant difference, tn = not significant.

The research results indicate that the concentration of POC in rabbit urine and the watering interval are significantly different, with the highest results observed in the K3I2 treatment at a concentration of 60 ml/l water and a watering interval of every 4 days.

3.5 Dry Weight

Based on the analysis of variance obtained, the treatment of liquid organic fertilizer doses from rabbit urine and the watering interval significantly affected the growth of romaine lettuce plants in terms of dry weight. To determine the differences, further tests were conducted using BNJ at 5% and 1%.

Table 5. Average treatment of time intervals and doses of liquid rabbit urine fertilizer on dry weight

Treatment	Average	Notation
K1I1	46.13	b
K1I2	20.90	a
K1I3	17.37	a
K2I1	28.13	a
K2I2	39.33	b
K2I3	19.80	a
K3I1	36.00	b
K3I2	66.73	c
K3I3	20.53	a
BNJ	5.69	

Note: Identical numbers in the same column indicate no significant difference, n.s. = not significant.

The research results indicate that the concentration of POC in rabbit urine and the watering interval are significantly different, with the highest results observed in the K3I2 treatment at a concentration of 60 ml/l water and a watering interval of every 4 days.

3.6 Discussion

The treatment of rabbit urine liquid organic fertilizer dosage and application interval time on the growth of romaine lettuce plants can affect growth parameters such as the number of leaves and plant height. Rabbit urine contains various

essential nutrients such as nitrogen, phosphorus, and potassium that are important for plant growth. Nitrogen is very important for leaf and foliage formation, while phosphorus and potassium support root development and stem strength [14]. The right dose of liquid organic fertilizer from rabbit urine can provide sufficient nutrients without causing harmful excesses. Too low a dose may not provide enough nutrients, while too high a dose can cause plant toxicity and damage soil structure. The application interval of fertilizer affects the continuous availability of nutrients to plants. Too long an interval can cause nutrient deficiencies between applications, while too short an interval can cause nutrient accumulation and potential over-fertilization [15].

The appropriate treatment of liquid rabbit urine organic fertilizer dosage and the appropriate application interval can have a positive impact on the growth of romaine lettuce [16]. Optimal nutrition through this organic fertilizer can increase the number of leaves and plant height, which ultimately improves the quality and quantity of the harvest. It is important to conduct trials and direct observations in the field to determine the most effective dosage and interval for the specific conditions of the plants and their growing environment [17].

The treatment of rabbit urine liquid organic fertilizer dosage and application interval on romaine lettuce growth had a significant effect on root length, wet weight, and dry weight of plants [18]. Rabbit urine, which is rich in essential nutrients such as nitrogen, phosphorus, and potassium, plays an important role in supporting optimal plant growth. The right dosage ensures that plants get enough nutrients to develop long and strong roots and increase the water content in plant tissues, which is reflected in wet weight. In addition, the dry weight of plants also increases along with optimal nutrient absorption and utilization, which supports the formation of denser and healthier biomass. Application intervals adjusted to the plant growth stage ensure continuous nutrient availability, preventing nutrient deficiencies or excesses that can harm plants. Thus, the combination of the right fertilizer dosage and application interval can increase fertilizer use efficiency and overall romaine lettuce yield [19].

4 Conclusion

The treatment of rabbit urine POC concentration and watering interval had a very significant effect on the number of leaves, wet weight, and dry weight, with the best results at a concentration of 60 ml/L of water and a watering interval of once every 4 days (K312). In terms of plant height, the treatment interaction was not significant, but individually, a concentration of 60 ml/L water produced the highest plant height, while a watering interval of every 2 days showed the best results, except at 28 and 35 days after sowing, which showed no significant difference. Meanwhile, root length showed no significant effect either on the treatment interaction or on each individual treatment.

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