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The Effect of Liquid Organic Fertilizer from Rumen Contents Fermentation on the Growth and Yield of Caisim (*Brassica chinensis* var. *parachinensis*)

Efek Pemberian Pupuk Organik Cair Hasil Fermentasi Isi Rumen Terhadap Pertumbuhan dan Hasil Caisim (Brassica chinensis var. parachinensis)

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ABSTRAK

Sawi Caisim (*Brassica chinensis* var. *parachinensis*) ialah tanaman sayuran yang memiliki nilai ekonomi tinggi dan seringkali menjadi pilihan utama bagi petani karena pertumbuhannya yang cepat dan hasil panennya yang melimpah. Pupuk organik cair yang dihasilkan dari fermentasi isi rumen ternak menjadi alternatif yang menarik. Fermentasi isi rumen dapat menghasilkan pupuk organik cair yang kaya akan nutrisi tanaman, seperti nitrogen, fosfor, dan unsur hara lainnya. Tujuan penelitian ini yaitu untuk mengetahui pengaruh Pupuk Organik Cair (POC) hasil fermentasi isi rumen dan mendapatkan konsentrasi terbaik untuk pertumbuhan dan hasil tanaman sawi caisim. Penelitian ini menggunakan Rancangan Acak Kelompok (RAK) yang terdiri dari 7 perlakuan, masing-masing perlakuan diulang sebanyak 3 kali. Perlakuan tersebut mencakup berbagai konsentrasi POC, mulai dari tanpa POC, konsentrasi POC 25 mL.L-1, 50 mL.L-1, 75 mL.L-1, 100 mL.L-1, 125 mL.L-1, dan 150 mL.L-1. Parameter pengamatan meliputi tinggi tanaman, jumlah daun, klorofil daun, bobot basah, dan bobot kering tanaman sawi caisim. Hasil penelitian menunjukkan bahwa perlakuan dengan konsentrasi POC sebanyak 150 mL.L-1 menghasilkan hasil terbaik, tinggi tanaman 36,65 cm, jumlah daun mencapai 15,35 helai, berat basah 135,80 g, berat kering 19,37 g dan klorofil daun 14,50 mg.g-1. Penelitian ini memberikan bukti konkret bahwa POC hasil fermentasi isi rumen memiliki potensi besar sebagai pupuk organik yang ramah lingkungan dan berkelanjutan dalam pertanian modern. Hasil ini mendorong penerapan lebih lanjut dari POC hasil fermentasi isi rumen sebagai alternatif pupuk organik yang efektif dalam mendukung pertumbuhan tanaman dan produksi hasil pertanian ramah lingkungan.

Kata Kunci:

POC fermentasi isi rumen;

sawi caisim.

ABSTRACT

Caisim (Brassica chinensis var. parachinensis) is a high-value vegetable crop often chosen by farmers due to its rapid growth and abundant harvest. Liquid organic fertilizer derived from rumen fermentation presents an intriguing alternative. Rumen fermentation produces nutrient-rich liquid organic fertilizer, containing essential plant nutrients like nitrogen, phosphorus, and others. This study aims to determine the impact of Liquid Organic Fertilizer (LOF) from rumen fermentation and identify the optimal concentration for the growth and yield of caisim. A Randomized Complete Block Design (RCBD) was employed with a single factor comprising 7 treatments, each replicated three times. Treatments included various LOF concentrations: control (without LOF), 25 mL.L-1, 50 mL.L-1, 75 mL.L-1, 100 mL.L-1, 125 mL.L-1, and 150 mL.L-1. Observational parameters encompassed plant height, leaf count, leaf chlorophyll content, fresh weight, and dry weight of caisim. Results indicated that the treatment with 150 mL.L-1 LOF concentration yielded the best outcomes, with a plant height of 36.65 cm, 15.35 leaves, fresh weight of 135.80 g, dry weight of 19.37 g, and leaf chlorophyll content of 14.50 mg.g-1. This study provides tangible evidence that rumen fermentation-derived LOF has significant potential as an environmentally friendly and sustainable organic fertilizer in modern agriculture. These findings encourage further implementation of rumen fermentation-derived LOF as an effective alternative organic fertilizer supporting environmentally friendly plant growth and agricultural production.

Keywords:

LOF from rumen content fermentation;

caisim.

INTRODUCTION

Caisim (Brassica chinensis var. parachinensis) is a vegetable plant that plays a crucial role in supporting the food needs of the community. Known for its dark green leaves and tender stems, *caisim* possesses high nutritional value. In Indonesia, *caisim* has become a sought-after vegetable commodity and is widely cultivated by farmers. Fertilization attention is a key factor for achieving optimal production results from this plant.

Fertilizer application is a cultivation practice that significantly influences plant growth and yield. The use of liquid organic fertilizer has become an increasingly popular alternative, mainly due to its potential to enhance soil and plant fertility. In this context, liquid organic fertilizer from rumen content fermentation attracts attention as a type of organic fertilizer that can positively impact the growth and yield of *caisim*.

Liquid organic fertilizer from rumen content fermentation contains essential nutrients for plants. Rumen content includes microorganisms and nutrients found in animal feed. Through the fermentation process, these nutrients can be transformed into a form readily absorbed by plants, allowing plants to utilize them optimally. Therefore, the application of liquid organic fertilizer from rumen content fermentation is expected to enhance nutrient availability for *caisim*, subsequently influencing its growth and harvest yield (Damayanti et al., 2018).

The utilization of liquid organic fertilizer from rumen content fermentation can be an effective solution. This fertilizer not only provides essential nutrients for plants but also enhances microbial activity in the soil, consequently improving soil health and nutrient availability. Liquid organic fertilizer from rumen content fermentation is produced through the fermentation process of raw materials derived from the rumen content of ruminant animals, such as cows or sheep. Rumen content contains a significant amount of microorganisms, bacteria, and nutrients originating from the consumed animal feed. This fermentation process involves the activity of microorganisms in breaking down complex organic matter into simpler compounds easily absorbed by plants (Damayanti et al., 2018; Lehar, 2010).

The results of fermentation can be in the form of liquid or solid organic fertilizer. In Indonesia, a considerable amount of rumen content is wasted. Lehar (2010) reported that an average of approximately 27.5 tons of rumen content is wasted each year, primarily due to the lack of awareness of its benefits among the community. With the increasing demand for beef, it is estimated that more rumen content will be discarded in the last few years.

The research results by Burham et al. (2016) reported that applying a concentration of 15 ml L-1 bioactivator liquid organic fertilizer (POC) and using the bioactivator liquid organic fertilizer (POC) twice could enhance the yield of green mustard plants (Brassica juncea L.). This improvement was evident in the form of fresh consumption weight per plant, which reached 399.76 g, representing a 29.60% increase compared to the control. The research results from Asparingga & Widyawati (2023) indicate that the treatment with a concentration of 25 $mL.L^{-1}$ Gliricidia sepium leaf POC is the most effective and can enhance the growth and yield of pakcoy mustard plants. This is supported by a plant height of 22.73 cm, a leaf count of 11.08 leaves, leaf chlorophyll content of 9.90 $mg.g^{-1}$, a wet canopy weight of 162.58 g, and a dry canopy weight of 14.15 g. Attention to effective fertilization becomes increasingly crucial, given the variations in soil conditions and weather that can affect nutrient availability for plants. *Caisim* growing in nutrient-rich

soil conditions has a greater chance of producing healthy and productive plants. Therefore, this research aims to determine the effect of Liquid Organic Fertilizer (LOF) from rumen content fermentation and obtain the optimal concentration for the growth and yield of *caisim* plants.

Thus, a deeper understanding of the impact of liquid organic fertilizer from rumen content fermentation can contribute positively to sustainable agricultural practices. The use of organic fertilizers can help reduce farmers' dependence on chemical fertilizers, which tend to have negative environmental impacts. Understanding how liquid organic fertilizer can enhance plant productivity can encourage the development of environmentally friendly farming practices.

METHODOLOGY

This research was conducted on the land of the Abdi Laboratus Self-Sufficient Agriculture and Rural Training Center (SSARTC) from April to November 2023. The materials used in this study were *caisim* vegetable seeds, *turi* leaves, sugar water, cattle rumen, and 95% alcohol. The tools used in this study included a hoe, bucket, machete, shovel, measuring glass, sieve, scale, barrel/bucket, 20 L jerry can, electric oven, ruler, digital thermometer, cuvette tubes, UV-Vis Spectrophotometer (Ultraviolet-Visible), tray, writing tools, camera, and auger.

The study employed a randomized complete block design (RCBD) with a single factor consisting of 7 treatments and 4 replications. The treatments tested were as follows: P0=Without LOF 0 $mL.L^{-1}$; P1=LOF concentration 25 $mL.L^{-1}$; P2=LOF concentration 50 $mL.L^{-1}$; P3=LOF concentration 75 $mL.L^{-1}$; P4=LOF concentration 100 $mL.L^{-1}$; P5=LOF concentration 125 $mL.L^{-1}$; P6=LOF concentration 150 $mL.L^{-1}$. Each experimental plot contained 30 plants, with 6 plant samples in each plot, resulting in a total of 168 plant samples. Land preparation and construction of embankments were done on 21 plots, with plot dimensions of 1.5 m x 1.20 m and embankment height of 30 cm. The distance between treatment plots was 30 cm, the distance between replications was 50 cm, and the planting distance was 20 x 30 cm.

The preparation of Sesbania grandiflora leaves for Liquid Organic Fertilizer (LOF) from rumen content fermentation involves placing 4 kg of fresh legume leaves (Sesbania grandiflora) into a jerry can until compacted. Subsequently, this is mixed with a solution comprising 18 L of water, 420 cc of rumen fluid, and 420 cc of sugar water. The mixture is then tightly sealed in anaerobic conditions. Stirring is performed on the second day to release gas, followed by daily stirring. It is important not to prolong the stirring duration during the open period to prevent easy nitrogen evaporation (Lehar, 2010). After 14 days, the resulting mixture is squeezed to separate solid material (dregs) and liquid organic material. The liquid is then stored in a closed container (jerry can). Subsequently, the rumen content fermentation material undergoes laboratory analysis to determine the content of N, P, and K.

The application of LOF was given two weeks before planting. Subsequent intervals were performed every week until the plants were 35 days old after planting (DAP). The application method was as follows: 1) Measure LOF 25 mL + water 975 mL, then mix evenly and apply to *caisim* plants according to the treatment. 2) Measure LOF 50 mL + water 950 mL, then mix evenly and apply to *caisim* plants according to the treatment. 3) Measure LOF 75 mL + water 925 mL, then mix evenly and apply to *caisim* plants according to the treatment. 4) Measure LOF 100 mL + water 900 mL, then mix evenly and apply to *caisim* plants

according to the treatment. 5) Measure LOF 125 mL + water 875 mL, then mix evenly and apply to *caisim* plants according to the treatment. 6) Measure LOF 150 mL + water 850 mL, then mix evenly and apply to *caisim* plants according to the treatment.

Observation parameters included plant height, leaf count, leaf chlorophyll, wet weight, and dry weight of *caisim* plants. The experimental data were analyzed using analysis of variance (ANOVA), and if there were significant effects between treatments, a further Tukey's Honestly Significant Difference (HSD) test was conducted at a 5% significance level.

RESULTS AND DISCUSSION

Plant Height (cm)

Based on the analysis of variance, it is indicated that the concentration of liquid organic fertilizer from rumen content fermentation has no significant effect on the height of *caisim* plants at 1 WAF and 3 WAF. However, it significantly influences the plant height at 2 WAF The Tukey's Honestly Significant Difference (HSD) test at a 5% level was conducted, and the average height of *caisim* plants at various concentrations of Liquid Organic Fertilizer from Rumen Content Fermentation from 1 WAF to 3 WAF is presented in (Table 1).

Table 1 shows that observations of plant height parameters at the 1 WAF observation time for the concentration treatment of 150 mL.L-1 have the highest plant height value (11.52 cm), but it does not significantly differ from other treatments. Meanwhile, observations of plant height parameters at the 2 WAF observation time for the concentration treatment of 150 mL.L-1 have the highest plant height value (23.23 cm), but it does not significantly differ from the P5=125 mL.L-1 treatment, which has a plant height value of 23.08 cm. However, it significantly differs from all other treatments. Observations of plant height at 3 WAP indicate that the concentration treatment of 150 mL.L-1 has the highest plant height value (36.65 cm), but it does not significantly differ from other treatments.

Number of leaves

Table 2 shows that observations of the number of leaves at 3 WAP for the concentration treatment of 150 mL.L-1 have the highest number of plant leaves (15.35 leaves) and significantly differ from other treatments in terms of quantity. Meanwhile, observations at 1 WAF and 2 WAF have not yet indicated a significant difference among these treatments.

Table 1. The average height of caisim plants from the application of Liquid Organic Fertilizer (LOF) from Rumen Content Fermentation

Concentration LOF ($mL.L^{-1}$)	Plant height (cm)		
	1 weeks after planting (WAF)	2 weeks after planting (WAF)	3 weeks after planting (WAF)
Without LOF	10,55	16,68 a	31,49
25 $mL.L^{-1}$	11,33	17,51 a	32,00
50 $mL.L^{-1}$	11,49	19,27 b	32,07
75 $mL.L^{-1}$	11,51	19,68 b	33,55
100 $mL.L^{-1}$	11,51	19,77 b	35,22
125 $mL.L^{-1}$	11,51	23,08 c	36,33
150 $mL.L^{-1}$	11,52	23,23 c	36,65
HSD 5%	ns	1,28	ns

Note: Numbers accompanied by the same letter at the same observation time indicate no significant difference, as determined by the Tukey's Honestly Significant Difference (HSD) test at a 5% significance level (ns = not significant)

Table 2. The average number of leaves of caisim plants due to the application of Liquid Organic Fertilizer from Rumen Content Fermentation

Concentration LOF ($mL.L^{-1}$)	Number of leaves (leaves)		
	1 weeks after planting (WAF)	2 weeks after planting (WAF)	3 weeks after planting (WAF)
Without LOF	4,87	6,45	9,16a
25 $mL.L^{-1}$	5,00	6,62	9,37a
50 $mL.L^{-1}$	5,54	7,16	9,37a
75 $mL.L^{-1}$	5,58	7,62	9,41a
100 $mL.L^{-1}$	5,62	7,75	10,20a
125 $mL.L^{-1}$	5,70	7,87	12,54b
150 $mL.L^{-1}$	5,88	8,37	15,35c
HSD 5%	ns	ns	1,4

Note: Numbers accompanied by the same letter at the same observation time indicate no significant difference, as determined by the Tukey's Honestly Significant Difference (HSD) test at a 5% significance level (ns = not significant)

Table 3. Average wet weight of caisim plants from the application of liquid organic fertilizer from rumen content fermentation

Concentration LOF ($mL.L^{-1}$)	Wet Weight of Plants (g)
Without LOF	28,58a
25 $mL.L^{-1}$	33,92a
50 $mL.L^{-1}$	45,67b
75 $mL.L^{-1}$	57,83bc
100 $mL.L^{-1}$	68,17c
125 $mL.L^{-1}$	111,08d
150 $mL.L^{-1}$	135,80e
HSD 5%	13,96

Note: Numbers accompanied by the same letter indicate no significant difference based on the Tukey's Honestly Significant Difference (HSD) test at a 5% significance level

Wet Weight of Plants (g)

The analysis of variance results shows that the concentration of liquid organic fertilizer from rumen content fermentation treatments significantly affects the wet weight of *caisim* plants. The average wet weight of *caisim* plants is presented in (Table 3).

Dry Weight of Plants (g)

The analysis of variance results indicates that the concentration of liquid organic fertilizer from rumen content fermentation treatments significantly affects the dry weight of *caisim* plants. The average dry weight of *caisim* plants is presented in (Table 4).

Tables 3 and 4 above show that the parameters of wet weight and dry weight of *caisim* plants in the treatment with a concentration of 150 $mL.L^{-1}$ have the highest wet weight (135.80 g) and dry weight (19.37 g), and they significantly differ from other treatments. Meanwhile, the lowest wet weight of *caisim* plants is found in the treatment without the application of liquid organic fertilizer or a concentration of 0 $mL.L^{-1,}$ with 28.58 g and it is not significantly different from the treatment with a concentration of 25 $mL.L^{-1}$ (Table 3) For the lowest dry weight of *caisim* plants, it is found in the treatment with a concentration of 0 $mL.L^{-1}$ (7.17 g), which is not significantly different from the treatment with a concentration of 25 $mL.L^{-1}$ (7.50 g), 50 $mL.L^{-1}$ (9.00 g), and 75 $mL.L^{-1}$ (9.33 g) (Table 4).

Table 4. The average dry weight of caisim plants from the application of rumen content fermentation LOF

Concentration LOF (mL.L^{-1})	Dry Weight of Plants (g)
Without LOF	7,17a
25 mL.L^{-1}	7,50a
50 mL.L^{-1}	9,00a
75 mL.L^{-1}	9,25a
100 mL.L^{-1}	9,33a
125 mL.L^{-1}	13,25b
150 mL.L^{-1}	19,37c
HSD 5%	3,82

Note: Numbers accompanied by the same letter indicate no significant difference based on the Tukey's Honestly Significant Difference (HSD) test at a 5% significance level

Table 5. Average chlorophyll content in caisim mustard plant leaves from the application of liquid organic fertilizer from rumen content fermentation

Concentration LOF (mL.L^{-1})	Chlorophyll Leaf (mg.g^{-1})
Without LOF	13,29
25 mL.L^{-1}	13,30
50 mL.L^{-1}	13,51
75 mL.L^{-1}	13,59
100 mL.L^{-1}	14,35
125 mL.L^{-1}	14,47
150 mL.L^{-1}	14,50
HSD 5%	ns

Note: Numbers accompanied by the same letter indicate no significant difference based on the Tukey's Honestly Significant Difference (HSD) test at a 5% significance level

Chlorophyll Leaf (mg.g^{-1}).

The results of the analysis of variance indicate that the concentration of liquid organic fertilizer from fermented gamal leaves in the rumen content of cattle does not significantly differ in terms of the amount of chlorophyll in *caisim* mustard plants. The average amount of chlorophyll in *caisim* mustard plant leaves can be seen in (Table 5).

Table 5 above indicates that the average leaf chlorophyll tends to increase with the rising concentration levels. The highest average leaf chlorophyll content is found in the treatment with a concentration of 150 mL.L-1 (14.50 mg.g-1), but it does not significantly differ from other treatments.

DISCUSSION

Plant Growth Components

Plant growth involves an increase in plant height, leaf count, and dry weight that cannot revert to their original form. This reflects the irreversible nature of plant growth, where there is an irreversible increase in plant height, leaf count, and dry weight that cannot return to the original shape or size. This growth process is irreversible and results in the formation of permanent structures in plants.

The growth of *caisim* mustard plants responds differently to the application of liquid organic fertilizer from rumen content fermentation. It is suspected that genetic factors and the application of liquid organic fertilizer from rumen content fermentation concentrations stimulate higher plant growth components compared to those without the application of liquid

organic fertilizer from rumen content fermentation.

The plant growth process is controlled by two factors: internal factors (genetics and hormones) and external factors (the plant growing environment). *Caisim* mustard plants may possess genetic adaptation abilities to specific environmental conditions. Plants growing in various environmental conditions may exhibit genetic adaptations that enable them to survive and thrive effectively (Lehar, 2010).

The application of liquid organic fertilizer concentration from rumen content fermentation affects plant growth components, namely the height and leaf count of *caisim* mustard plants. The concentration of organic fertilizer given to *caisim* mustard plants is part of the growing environment that supports the growth of these plants. Observations on plant growth reveal that the application of fermented rumen-content liquid organic fertilizer at a concentration of 150 $mL.L^{-1}$ resulted in the highest number of leaves (15.35 leaves). Liquid organic fertilizer from rumen content fermentation can provide essential nutrients such as nitrogen, phosphorus, and potassium (Table 6).

The laboratory analysis results in Table 6 above indicate that the content of cattle rumen POC contains several nutrients such as organic C, N, P, K, and Mg. The main function of C-organic is to provide energy for soil microbes, enhance soil fertility, maintain soil structure, and store carbon in the soil and global carbon cycle. Nitrogen is crucial for vegetative growth and protein formation. Phosphorus aids in energy formation and cell division, while potassium plays a role in water balance and plant tissue development and magnesium plays a role in activating many enzymes in plants. The availability of these nutrients can influence plant growth components, including plant height, leaf count, and leaf area (Damayanti et al., 2018; Lehar, 2010; Manullang et al., 2014; Novriani, 2016; Wasis & Badrudin, 2018). Nitrogen abundance also promotes rapid growth, including increased plant height, and larger and darker green leaves and stems, and encourages vegetative growth above the ground (Rahmah et al., 2014).

Yield Components

Tables 3 and 4 show that the treatment of liquid organic fertilizer concentration from rumen content fermentation at a concentration of 150 $mL.L^{-1}$ has the highest values, namely a wet weight of 135.80 g and a dry weight of 19.37 g. This is suspected to be caused by the nitrogen (N) and potassium (K) content present in the liquid organic fertilizer from rumen content fermentation, which may contribute to the increase in the fresh weight of of *caisim* mustard plants. Nitrogen is essential for strong vegetative growth and protein formation, supporting the development of lush leaves and stems. Meanwhile, potassium regulates water balance in plant cells and optimizes photosynthesis processes, resulting in better carbohydrate production and growth. The combination of these nutrients ensures optimal vegetative growth and water balance in plants, ultimately leading to increased fresh weight and improved harvest yields (Damayanti et al., 2018; Sari et al., 2015).

Table 6. Results of organic content analysis of cattle rumen content (organic C, N, P, K, and Mg)

No	Sample Code	C-Org	N	P	K	Mg
				(%)		
1	POC (Cattle Rumen)	4,93	2,15	1,13	1,01	1,05

Source: Soil Chemistry Laboratory, Faculty of Agriculture, Nusa Cendana University, (2023).

The wet weight of the plant canopy is related to the length of the *caisim* mustard plant leaves, which affects the amount of photosynthesis and, consequently, increases the wet weight of the plant canopy. Duaja (2012) states that the longer and wider the leaves, the greater the wet weight produced. The wet weight of plants is also related to the amount of absorbed water, thereby increasing the wet weight of the *caisim* mustard plant canopy. The application of liquid organic fertilizer concentration significantly affects the wet weight of *caisim* mustard plants, with an 18% concentration producing an average of 64 g per plant (Oviyanti et al., 2016).

The use of natural materials as liquid organic fertilizer can increase plant production. The utilization of natural materials, whether in solid or liquid form, is capable of enhancing production by up to 25 tons per hectare of fresh *caisim* mustard per planting period (Aryani & Musbik, 2018). Plant growth involves photosynthesis, and dry weight, representing plant biomass, accumulates photosynthates from the photosynthesis process carried out by plants. The dry weight of plants results from the accumulation of carbohydrates available for plant growth throughout its lifespan. Therefore, if physiological processes in plants proceed well and are supported by efficient fertilization, it can increase the dry weight of plants. The larger the dry weight, the more efficient the photosynthesis process, leading to higher and faster productivity and the development of tissue cells, thereby enhancing overall plant growth (Oviyanti et al., 2016; Susanti, 2011).

The reduction in plant dry weight associated with simultaneous plant growth will decrease the overall plant dry weight (Susanti, 2011). Plant dry weight is a crucial indicator of growth for *caisim* mustard plants because it indicates that the plant can perform photosynthesis effectively, ensuring smooth vegetative growth. The dry weight of plants is inseparable from the number and width of leaves, as the quantity and width of leaves will influence the photosynthesis process in plants (Aryani & Musbik, 2018; Oviyanti et al., 2016; Susanti, 2011).

The process of photosynthesis produces carbohydrates converted into proteins, meaning that the addition of elements to the leaves will also increase the plant's dry weight. This aligns with the research conducted by Tenri (2013) reporting that the application of liquid organic fertilizer concentration from gamal leaves significantly affects the dry weight of *caisim* mustard plants. The dry weight of *caisim* mustard plants indicates the optimization of nutrients synthesized by *caisim* plants, impacting the growth of *caisim* plants (Aisyah et al., 2011). Leaf formation in plants is greatly influenced by the availability of nitrogen and phosphorus nutrients in the medium, both of which play a role in the formation of new cells and major components of organic compounds in plants, such as amino acids, nucleic acids, chlorophyll, ADP, and ATP (Aisyah et al., 2011; Tenri, 2013).

CONCLUSION

The research results show that the treatment with Liquid Organic Fertilizer (LOF) from rumen content fermentation can significantly improve the growth and yield of *caisim* plants. Specifically, the treatment with an LOF concentration of 150 $mL.L^{-1}$ yielded the best results, with 15.35 leaves, a wet weight of 135.80 g, and a dry weight of 19.37 g. Meanwhile, the treatment with an LOF concentration of 150 $mL.L^{-1}$ did not show significance but produced high values for plant height at 36.65 cm and leaf chlorophyll content at 14.50 $mg.g^{-1}$.

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