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THE EFFECT OF APPLYING LIQUID ORGANIC FERTILIZER MADE FROM LEUCAENA LEAVES AND COW MANURE ON THE GROWTH AND YIELD OF CHINESE KALE (KAILAN)

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Abstract

This study evaluated the effects of lamtoro (Leucaena leucocephala) leaf liquid organic fertilizer and cow manure, individually and in combination, on the growth and production of kailan (Brassica oleracea L.). The experiment was conducted in Sunggal Kanan, Deli Serdang, North Sumatra, from March to May 2026 using a factorial randomized block design with three replications. The first factor was lamtoro leaf liquid organic fertilizer at 0, 65, and 130 mL L−1 water, while the second factor was cow manure at 0, 1, 2, and 3 kg plot−1. Observed variables were plant height, number of leaves, fresh weight per sample, and fresh weight per plot. Lamtoro leaf liquid organic fertilizer significantly affected plant height and fresh weight, with the highest sample fresh weight at 130 mL L−1 and the highest plot fresh weight at 65 mL L−1, but did not significantly affect leaf number. Cow manure significantly affected plant height and fresh weight, with favorable responses at 2 kg plot−1 for sample fresh weight and 3 kg plot−1 for plot fresh weight. The interaction between both fertilizers was not significant for all observed variables.

Keywords: cow manure; kailan; lamtoro leaf; liquid organic fertilizer; plant production

INTRODUCTION

Kailan (Brassica oleracea L.) is a leafy vegetable valued for its nutritional content, including minerals, protein, fiber, and vitamins. Its market value and consumer demand create a need for cultivation practices that can improve yield while maintaining soil quality. Intensification based mainly on inorganic fertilizer can increase production in the short term, but excessive and continuous use may contribute to declining soil quality and environmental contamination. Consequently, organic nutrient sources are increasingly considered as complementary or alternative inputs in vegetable production (Sinaga, 2018; Podesta et al., 2021; Ainiya et al., 2019).

Liquid organic fertilizer is produced from fermented plant or animal materials and can be applied through foliage or soil. Lamtoro is a leguminous plant with relatively high N, P, and K content and decomposes readily, making it potentially useful as a raw material for liquid organic fertilizer. Previous work has indicated that lamtoro-based liquid fertilizer can improve growth and yield of several vegetables when applied at suitable concentrations (Aulia & Makmur, 2020; Rizqika et al., 2022).

Cow manure provides organic matter and macro- and micronutrients, improves soil structure and water-holding capacity, and may support biological processes involved in nutrient mineralization. Its use is consistent with efforts to reduce dependence on inorganic fertilizer and strengthen sustainable production systems (Rosadi et al., 2019; Khan et al., 2021; Sanda & Hasnelly, 2023). However, the combined response of kailan to lamtoro leaf liquid organic fertilizer and cow manure requires empirical evaluation because the two inputs may act independently or interact in influencing plant growth.

This study therefore aimed to determine: (1) the effect of lamtoro leaf liquid organic fertilizer on kailan growth and production; (2) the effect of cow manure on kailan growth and production; and (3) the interaction between both fertilizer treatments. The study focused on plant height, leaf number, fresh weight per sample, and fresh weight per plot.

LITERATURE REVIEW

Kailan Growth Requirements

Kailan grows well in loose soil with a pH of approximately 5.5–6.5 and can adapt to several soil textures. Suitable environmental conditions include moderate temperature and adequate moisture, although excessive rainfall and poor

drainage can limit growth. Its productivity is influenced by both genetic characteristics and environmental factors, particularly nutrient availability, water status, temperature, and light (Samadi, 2018; Kumalasari et al., 2022).

Lamtoro Leaf Liquid Organic Fertilizer

Lamtoro leaves contain macro- and micronutrients that may contribute to plant nutrition. Reported nutrient components include nitrogen, phosphorus, potassium, calcium, and magnesium. Their relatively rapid decomposition can support nutrient availability, while liquid formulations can facilitate application. Research on lamtoro-based liquid fertilizer has reported positive responses in plant height, leaf development, and fresh biomass when concentrations are appropriate (Kurniati et al., 2017; Rizqika et al., 2022; Elfarisna et al., 2023).

Cow Manure

Cow manure contributes organic matter and nutrients to the soil and can improve aggregate stability, cation exchange capacity, porosity, and water retention. These improvements may enhance root growth and nutrient uptake. Nitrogen supports vegetative growth and chlorophyll formation, phosphorus contributes to root development and energy transfer, and potassium supports enzyme activation, water regulation, carbohydrate formation, and stress tolerance (Parnata, 2018; Riyawati, 2022; Firmansyah et al., 2017).

Research Hypotheses

The study tested three hypotheses: lamtoro leaf liquid organic fertilizer affects kailan growth and production; cow manure affects kailan growth and production; and the interaction of both fertilizers affects kailan growth and production.

METHOD

Research Site, Materials, and Experimental Design

The experiment was conducted at Jl. Setia Makmur, Sunggal Kanan, Sunggal District, Deli Serdang Regency, North Sumatra Province, from March to May 2026. Materials included NITA F1 kailan seed, lamtoro leaf liquid organic fertilizer, cow manure, and polybags. The experiment used a factorial randomized block design with two treatment factors and three replications.

Factor L was lamtoro leaf liquid organic fertilizer at three levels: L0 = 0 mL L−1 water (control), L1 = 65 mL L−1 water, and L2 = 130 mL L−1 water. Factor S was cow manure at four levels: S0 = 0 kg plot−1 (control), S1 = 1 kg plot−1, S2 = 2 kg plot−1, and S3 = 3 kg plot−1. The 3 × 4 factorial arrangement produced 12 treatment combinations and 36 experimental plots. Each plot measured 120 × 90 cm, contained 12 plants at 30 × 30 cm spacing, and four plants per plot were selected as samples.

Preparation of Lamtoro Leaf Liquid Organic Fertilizer

The lamtoro leaf liquid organic fertilizer was prepared by blending lamtoro leaves and placing the material in a plastic container. Ten liters of water, 1 kg of sugar dissolved in 500 mL of water, and 15 mL of EM-4 were added and mixed thoroughly. The container was closed and the mixture was fermented for three weeks, with routine observation and stirring. The fertilizer was considered ready for field application after the mixture turned brownish and no longer produced a strong odor.

Treatment Application and Observations

Cow manure was incorporated during the final soil preparation according to treatment. Lamtoro leaf liquid organic fertilizer was applied beginning one week after transplanting, three times at one-week intervals. Standard maintenance included irrigation, replacement of dead plants, weeding, soil loosening, and manual or botanical pest control. Harvest was conducted at approximately 40 days. Plant height and leaf number were recorded weekly from 2 to 4 weeks after planting, while fresh weight per sample and fresh weight per plot were measured at harvest.

Statistical Analysis

Data were analyzed using analysis of variance for a factorial randomized block design. The linear model was $Yijk = \mu + \rho i + Lj + Sk + (LS)jk + \varepsilon ijk$, where ρi represents the block effect, Lj the lamtoro liquid fertilizer effect, Sk the cow manure effect, and (LS)jk their interaction. When treatment effects were significant, mean separation was conducted using Duncan's multiple range test. Significance was interpreted using the reported 5% and 1% levels in the original analysis.

RESULTS AND DISCUSSION

Plant Height

Analysis of variance showed that lamtoro leaf liquid organic fertilizer and cow manure significantly affected plant height at 28 days after planting, whereas their interaction was not significant. The highest marginal mean for liquid fertilizer was observed at L2 (12.38 cm), while the highest cow manure mean was observed at S2 (12.33 cm). The L2S2 combination produced the numerically highest plant height (13.00 cm), but the interaction effect was not statistically significant.

Table 1. Mean plant height (cm) at 28 days after planting

Treatment	L0	L1	L2	Mean
S0	10.33	12.08	12.17	11.53abA
S1	10.92	10.67	11.75	11.11bA
S2	11.83	12.17	13.00	12.33aA
S3	12.25	12.08	12.58	12.31aA
Mean	11.33bA	11.75abA	12.38aA	

The positive response in plant height is consistent with the role of organic nutrient sources in improving nutrient availability and soil condition. Lamtoro liquid fertilizer supplies plant-derived nutrients, whereas cow manure contributes both nutrients and organic matter. Nitrogen availability is particularly relevant to vegetative growth, while phosphorus supports root development and nutrient acquisition (Jeksen & Mutiara, 2023; Siregar, 2019).

The regression analysis in the original experiment further described the treatment pattern. For lamtoro leaf liquid organic fertilizer, plant height followed the linear equation $\hat{Y} = 11.295 + 0.0081L$ with $R^2 = 0.9868$, indicating an increasing trend across the tested concentrations. For cow manure, the fitted relationship was cubic ($\hat{Y} = 11.528 - 2.1991S + 2.2639S^2 - 0.4815S^3$; $R^2 = 0.7507$). These equations describe the observed treatment means within the tested range and should not be interpreted as evidence for responses beyond those levels.

Number of Leaves

Neither lamtoro leaf liquid organic fertilizer, cow manure, nor their interaction significantly affected the number of leaves at 28 days after planting. The largest marginal mean for cow manure was observed at S2 (8.36 leaves), while the L2S2 treatment combination gave the numerically highest value (8.67 leaves). Because differences were not significant, these numerical patterns should not be interpreted as treatment superiority.

Table 2. Mean number of leaves at 28 days after planting

Treatment	L0	L1	L2	Mean
S0	7.58	8.08	7.75	7.81
S1	8.08	8.08	7.67	7.94
S2	8.42	8.00	8.67	8.36
S3	8.42	7.58	8.08	8.03
Mean	8.13	7.94	8.04	

The absence of a significant leaf-number response suggests that this trait may have been less sensitive to the nutrient differences generated by the treatments during the observation period. Leaf formation can also be strongly influenced by genotype and environmental conditions. Therefore, sufficient nutrient availability may increase biomass or plant height without necessarily producing a proportional increase in leaf number (Ibrahim & Tanaiyo, 2022).

Fresh Weight per Sample

Both fertilizer factors significantly affected fresh weight per sample, whereas the interaction was not significant. The L2 treatment produced the highest liquid-fertilizer marginal mean (543.33 g), and S2 produced the highest cow-

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manure marginal mean (580.00 g). The L1S3 combination yielded the numerically highest value (666.67 g), although this combination did not differ statistically through an interaction effect.

Table 3. Mean fresh weight per sample (g)

Treatment	L0	L1	L2	Mean
S0	350.00	473.33	466.67	430.00cA
S1	400.00	416.67	506.67	441.11bcA
S2	590.00	550.00	600.00	580.00aA
S3	383.33	666.67	600.00	550.00abA
Mean	430.83bA	526.67aA	543.33aA	

Fresh biomass integrates several growth processes, including nutrient uptake, photosynthesis, tissue expansion, and water accumulation. The significant main effects indicate that each fertilizer source independently contributed to biomass formation. Previous studies have similarly reported improved fresh weight following lamtoro-based liquid fertilizer or cow manure applications, although optimum rates vary with crop, substrate, and environmental conditions (Rizqika et al., 2022; Evelyn et al., 2018; Sanda & Hasnelly, 2023).

For fresh weight per sample, the lamtoro fertilizer response was represented by $\hat{Y} = 444.03 + 0.8654L$ with $R^2 = 0.8583$, while cow manure was represented by $\hat{Y} = 425.44 + 49.889S$ with $R^2 = 0.7207$. The source manuscript relates these responses to nutrient availability from both organic inputs. Lamtoro liquid fertilizer was reported to contain organic carbon and macro- and micronutrients, whereas cow manure contributes organic matter and nutrients that can improve soil conditions and nutrient uptake.

Nitrogen is particularly relevant to vegetative growth because it supports cell division and chlorophyll-related processes, while phosphorus contributes to root development and energy transfer. Potassium participates in stomatal regulation, enzyme activation, and carbohydrate formation. In the source discussion, these functions were used to explain why biomass-related variables responded more clearly than leaf number under the treatments applied.

Fresh Weight per Plot

Lamtoro leaf liquid organic fertilizer and cow manure significantly affected fresh weight per plot, while their interaction remained non-significant. The largest marginal mean for the liquid fertilizer factor occurred at L1 (1,795.83 g), whereas the largest cow-manure mean occurred at S3 (1,866.67 g). The highest numerical treatment combination was L1S1 (2,433.33 g). The different marginal optima between sample weight and plot weight indicate that treatment response was not strictly linear across all yield indicators.

Table 4. Mean fresh weight per plot (g)

Treatment	L0	L1	L2	Mean
S0	1016.67	1350.00	1233.33	1200.00bB
S1	916.67	2433.33	1766.67	1705.56aAB
S2	1650.00	1700.00	1733.33	1694.44abAB
S3	1666.67	1700.00	2233.33	1866.67aA
Mean	1312.50bA	1795.83aA	1741.67aA	

Organic matter from manure can improve soil physical properties, water retention, nutrient storage, and microbial activity, while potassium and other nutrients contribute to carbohydrate formation and transport. These mechanisms provide a plausible explanation for the observed increase in plot fresh weight under several manure treatments (Sutanto, 2018; Sulkan et al., 2019; Dafiq, 2019).

The fresh-weight-per-plot response also showed positive fitted trends. Lamtoro leaf liquid organic fertilizer followed $\hat{Y} = 1402.1 + 3.3013L$ with $R^2 = 0.6567$, and cow manure followed $\hat{Y} = 1318.3 + 198.89S$ with $R^2 = 0.7909$. Although these regressions indicate increasing fitted values over the experimental levels, the highest marginal mean for lamtoro fertilizer occurred at L1 rather than L2. This distinction is important because the observed treatment means, rather than the fitted equation alone, determine the reported treatment comparison.

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Interaction between Lamtoro Liquid Fertilizer and Cow Manure

No significant interaction was observed for plant height, leaf number, fresh weight per sample, or fresh weight per plot. This indicates that the effect of one fertilizer factor was broadly independent of the level of the other factor within the tested ranges. A non-significant interaction does not imply that either input lacks agronomic value; rather, it indicates that their combined response did not depart sufficiently from the independent main effects to be detected statistically. This finding is consistent with the interpretation that two nutrient sources may support growth through parallel mechanisms without producing synergistic effects under a given set of environmental and management conditions (Hanafiah, 2019; Prabowo, 2022).

The source manuscript also notes that the absence of interaction may reflect the independent action of the two factors within the experimental environment. Plant growth is simultaneously influenced by genetic and environmental conditions, including water status, temperature, light, and nutrient availability. If one factor does not specifically enhance the effect of the other, the combined treatment may remain statistically non-significant even when each factor has a significant main effect. Accordingly, the present results support separate main effects of lamtoro liquid fertilizer and cow manure on several growth and yield variables, but not a synergistic interaction under the tested conditions.

CONCLUSION

Lamtoro leaf liquid organic fertilizer significantly affected plant height, fresh weight per sample, and fresh weight per plot, but did not significantly affect leaf number. The highest fresh weight per sample among the liquid-fertilizer levels occurred at 130 mL L−1 water, whereas the highest fresh weight per plot occurred at 65 mL L−1 water. Cow manure significantly affected plant height, fresh weight per sample, and fresh weight per plot, but not leaf number; the favorable levels were 2 kg plot−1 for fresh weight per sample and 3 kg plot−1 for fresh weight per plot. The interaction between lamtoro leaf liquid organic fertilizer and cow manure was not significant for any observed variable. Further research should refine the concentration and dosage ranges to identify combinations that maximize kailan growth and yield under different soil and environmental conditions.

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