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Effects of Household-Waste Liquid Organic Fertilizer And Compost on Pak Choi Growth**Alfreda Claudia Rahma*,
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Abstract. Household organic waste can be recycled into liquid organic fertilizer and compost for vegetable cultivation, but crop responses to their combined application may vary with treatment level. This study examined the growth responses of pak choi (*Brassica rapa* L.) to household-waste-derived liquid organic fertilizer and compost. A two-factor randomized complete block design comprised four reported liquid fertilizer concentrations (0, 100, 200, and 300 mL/L) and three compost rates (0, 100, and 200 g per polybag), with four replicates per combination (48 experimental units). Plant height, leaf number, leaf length, leaf width, estimated leaf area, SPAD readings, fresh mass, and root volume were evaluated. According to the reported variance analysis, compost affected leaf number and root volume, whereas interactions between the two inputs were reported for plant height, leaf length, leaf width, and leaf area. The combination of 200 mL/L liquid fertilizer and 200 g compost per polybag showed the highest reported means for plant height (21.20 cm), leaf length (13.62 cm), leaf width (8.12 cm), and leaf area (76.97 cm²), although several treatments shared statistical grouping letters for some variables. Neither chlorophyll readings nor fresh mass showed a significant treatment response in the reported analysis. These findings suggest a treatment-dependent vegetative response rather than demonstrated improvement in harvest productivity. Interpretation remains subject to verification of the original statistical output and several marginal means.

Keywords: *Brassica rapa*; compost; household organic waste; liquid organic fertilizer; vegetative growth.

INTRODUCTION

Brassica rapa L. is a leafy vegetable valued for its relatively short cultivation period and edible foliage. Maintaining adequate growth under container-based cultivation depends partly on the availability of nutrients and suitable rooting conditions. Organic inputs are increasingly considered in vegetable production because they provide an opportunity to recycle biodegradable residues while supporting soil management (Yulina *et al.*, 2023; Goldan *et al.*, 2023). However, the effects of an amendment depend on its composition,

application rate, and the growing environment.

Household organic residues can be processed into compost or liquid organic fertilizer (LOF), thereby creating two materials with potentially different nutrient-release patterns. Compost may alter soil structure and the availability of nutrients over time, whereas soluble constituents of LOF may become available more rapidly. Such responses are plausible mechanisms reported in the literature and should not be assumed without direct soil or fertilizer analysis (Ho *et al.*, 2022; Ayamba *et al.*, 2023; Bai *et al.*, 2023).

Previous pak choi studies indicate that organic fertilizer responses vary across fertilizer sources and rates. Mayun *et al.* (2024) evaluated household-waste LOF and reported growth responses under the conditions of their experiment, whereas Busyairi *et al.* (2024) examined compost rates in container cultivation. Studies of organic amendments have also reported responses in leaf development, growth, and soil characteristics (Lukmanasari, 2022; Anjani & Santoso, 2022; Alimuddin *et al.*, 2025). These findings provide a basis for examining both inputs in a shared experimental design.

The combined use of liquid and solid organic inputs requires particular attention because a main effect does not necessarily describe how a crop responds at each combination of fertilizer levels. Earlier work with pak choi and related vegetables has considered combinations of fertilizer forms, but interpretation can depend on growth stage and measured trait (Krismawati & Sugiono, 2021; Djana *et al.*, 2024; Panataria *et al.*, 2024). Separate evaluation of treatment combinations is therefore important in factorial experiments.

Different vegetative attributes also offer complementary rather than interchangeable information. Leaf number, length, width, and estimated area describe foliage development, while fresh mass and SPAD readings provide other observations of plant status. Significant differences in leaf dimensions do not establish an increase in marketable biomass if fresh mass itself does not respond significantly. Consequently, interpretation should distinguish individual vegetative responses from actual yield outcomes (Prayoga *et al.*, 2018; Safitri *et al.*, 2025).

Research on waste-based fertilizers has often described positive agronomic effects, but fertilizer composition and management determine whether those effects can be reproduced across locations.

Comparisons that use several application rates of both inputs can help identify combinations associated with distinct growth patterns and avoid attributing observed differences to unmeasured biochemical processes (Hamidah *et al.*, 2023; Seran *et al.*, 2025; Zendrato *et al.*, 2024).

The contribution of the present study is a two-factor evaluation of household-waste-derived liquid fertilizer and compost in container-grown pak choi under the reported experimental conditions. Specifically, this study aimed to assess the main and interaction responses of plant height, leaf number, leaf length, leaf width, estimated leaf area, SPAD readings, fresh mass, and root volume to LOF concentration and compost rate. The evaluation is restricted to the recorded variables and does not infer yield enhancement from leaf growth alone.

MATERIAL AND METHODS

Study Area and Plant Material

The experiment was conducted in Citangkil District, Cilegon City, Banten Province, Indonesia, from February to April 2026. Seeds of pak choi (*Brassica rapa* L.), Nauli F1 cultivar, were planted in 30 × 30 cm polybags containing a reported 5 kg of soil-based growing medium per polybag. The source study identified household-waste-derived liquid organic fertilizer and compost as the two experimental inputs but did not report their feedstock compositions or production protocols.

Experimental Design and Fertilizer Treatments

A two-factor randomized complete block design was reported. The liquid organic fertilizer (LOF) factor consisted of four levels: P0, 0 mL/L; P1, 100 mL/L; P2, 200 mL/L; and P3, 300 mL/L. The compost factor consisted of three rates: C0, 0 g/polybag; C1, 100 g/polybag; and



C2, 200 g/polybag. The 12 treatment combinations were assigned four replicates, giving 48 experimental units. The original report did not specify the criterion for blocking, the randomization procedure, or the number of plants retained in each unit; these details require confirmation from the researchers.

Compost was mixed with the growing medium according to the treatment rate. LOF applications were reported at 10, 15, 20, and 25 days after planting (DAP), following the application timing described by Afrida and Taher (2023). The source manuscript did not specify the dilution basis, the volume of solution applied per polybag, or the irrigation schedule; therefore, no numerical application volume is assumed here.

Measurements

The recorded response variables were plant height (cm), leaf number, leaf length (cm), leaf width (cm), estimated leaf area (cm²), chlorophyll meter reading (SPAD units), fresh mass (g), and root volume (cm³). The source tables explicitly identified 28 DAP for plant height and the four leaf-development variables. SPAD readings were recorded using a SPAD-502Plus instrument; root volume was measured by water displacement in a graduated cylinder. The timing and sample-selection details for the remaining variables require confirmation. Leaf area was estimated with the published expression reported in the source study, $LA_{0.5} = 0.393 + 0.705LW$ (Riza *et al.*, 2021), where L and W represent leaf length and width. The precise

interpretation of the subscript and the use of individual versus averaged leaf dimensions must be verified from the original method.

Statistical Analysis

According to the source manuscript, data were analyzed by analysis of variance (ANOVA) at a 5% significance level, followed by Duncan's multiple range test (DMRT) when treatment effects were significant. The original ANOVA tables, residual diagnostics, standard deviations, and software details were not supplied. Reported significance classifications and grouping letters have therefore been retained as reported, without generating new test statistics. Marginal means with clear arithmetic discrepancies were recalculated from the displayed treatment-cell means and flagged for verification against replicate-level data.

RESULTS AND DISCUSSION

Results

The reported factorial treatment responses varied among measured traits. Results are presented in Tables 1–8. In these tables, P0–P3 represent LOF concentrations of 0, 100, 200, and 300 mL/L, respectively, and C0–C2 represent compost rates of 0, 100, and 200 g/polybag, respectively.

Table 1 shows a reported interaction for plant height, with P2C2 attaining the largest numerical mean (21.20 cm). Its grouping letter overlaps with those of several other combinations, so it should not be described as uniquely superior to all treatments.

Table 1. Plant height (cm) of pak choi at 28 DAP under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	20.00 abc	18.97 abc	19.87 abc	19.62
P1 (100 mL/L)	17.42 c	17.32 c	18.70 abc	17.82
P2 (200 mL/L)	17.50 c	18.07 bc	21.20 a	18.92
P3 (300 mL/L)	20.75 ab	19.50 abc	18.00 bc	19.42
Column mean	18.92	18.47	19.44	—



For leaf number (Table 2), the source analysis indicated a compost main effect. The 200 g/polybag compost rate

had the largest column mean, whereas the two lower compost levels shared the same grouping letter.

Table 2. Leaf number of pak choi at 28 DAP under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	13.50	13.50	15.50	14.17
P1 (100 mL/L)	13.25	11.75	14.75	13.25
P2 (200 mL/L)	11.25	12.00	16.50	13.25
P3 (300 mL/L)	13.75	13.75	15.50	14.33
Column mean	12.94 b	12.75 b	15.56 a	—

The treatment combination P2C2 produced the greatest numerical leaf length (13.62 cm; Table 3), but multiple

treatment combinations shared at least one DMRT letter with this mean.

Table 3. Leaf length (cm) of pak choi at 28 DAP under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	11.25 cd	13.50 ab	11.75 bcd	12.17
P1 (100 mL/L)	11.37 cd	11.75 bcd	12.12 abcd	11.75
P2 (200 mL/L)	11.50 cd	10.87 d	13.62 a	12.00
P3 (300 mL/L)	12.87 abc	12.25 abcd	12.25 abcd	12.46
Column mean	11.75	12.09	12.43	—

The leaf width results also showed a reported interaction (Table 4). The P2C2

combination recorded the largest displayed mean (8.12 cm).

Table 4. Leaf width (cm) of pak choi at 28 DAP under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	6.15 bc	6.37 bc	6.32 bc	6.28
P1 (100 mL/L)	6.12 bc	5.95 bc	6.92 bc	6.33
P2 (200 mL/L)	5.75 c	6.85 bc	8.12 a	6.91
P3 (300 mL/L)	7.00 b	6.57 bc	6.82 bc	6.80
Column mean	6.26	6.44	7.05	—

For estimated leaf area (Table 5), P2C2 gave the largest numerical mean

(76.97 cm²); however, its reported statistical group overlapped with P3C0.

Table 5. Estimated leaf area (cm²) of pak choi at 28 DAP under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	50.14 bc	61.33 abc	53.51 bc	54.99
P1 (100 mL/L)	51.15 bc	49.88 bc	58.42 bc	53.15
P2 (200 mL/L)	49.35 c	55.78 bc	76.97 a	60.70
P3 (300 mL/L)	67.32 ab	59.21 bc	58.99 bc	61.84
Column mean	54.49	56.55	61.97	—

Chlorophyll meter readings varied numerically across treatments, but the original analysis did not identify

significant main or interaction effects (Table 6).

Table 6. Chlorophyll meter readings (SPAD units) of pak choi under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	38.60	38.15	39.87	38.87
P1 (100 mL/L)	40.37	40.72	40.95	40.68
P2 (200 mL/L)	40.52	42.42	40.70	41.22



LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P3 (300 mL/L)	37.45	39.85	37.27	38.19
Column mean	39.24	40.29	39.70	—

Fresh mass likewise showed no significant treatment effects in the source analysis (Table 7). The largest cell mean

(39.75 g at P2C2) was descriptive and should not be interpreted as a verified yield gain.

Table 7. Fresh mass (g) of pak choi under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	28.25	31.75	37.50	32.50
P1 (100 mL/L)	28.50	20.75	29.00	26.08
P2 (200 mL/L)	26.50	24.25	39.75	30.17
P3 (300 mL/L)	36.50	27.00	29.75	31.08
Column mean	29.94	25.94	34.00	—

Root volume showed a reported compost main effect (Table 8). The original DMRT notations grouped the 100 and 200 g/polybag rates together and distinguished them from the no-compost

rate. The recalculated mean for C2 is 82.31 cm³ based on the published treatment-cell means, pending verification from raw observations.

Table 8. Root volume (cm³) of pak choi under LOF and compost treatments

LOF level	C0 (0 g)	C1 (100 g)	C2 (200 g)	Row mean
P0 (0 mL/L)	81.75	82.00	82.00	81.92
P1 (100 mL/L)	81.50	82.00	82.75	82.08
P2 (200 mL/L)	81.75	82.75	82.25	82.25
P3 (300 mL/L)	81.75	82.00	82.25	82.00
Column mean	81.69 b	82.19 a	82.31 a	—

Discussion

The reported interactions for plant height and leaf dimensions indicate that the response to one fertilizer input depended on the level of the other. Therefore, the absence of a general LOF main effect should not be translated into the claim that LOF was ineffective at every compost rate. In particular, P2C2 was numerically high for several leaf-development traits, but overlapping DMRT letters prevent an exclusive claim of statistical superiority (Djana *et al.*, 2024; Panataria *et al.*, 2024).

The compost-related response in leaf number may be consistent with the broader literature on the potential effects of organic amendments on growing media and nutrient cycling. However, nutrient availability, pH, soil porosity, and microbial activity were not measured in

this study; they must therefore remain hypotheses rather than directly established mechanisms (Ayamba *et al.*, 2023; Ho *et al.*, 2022; Goldan *et al.*, 2023). Studies of pak choi have similarly documented context-dependent responses to compost and related organic inputs (Alimuiddin *et al.*, 2025; Krismawati & Sugiono, 2021).

Leaf dimension and estimated-area patterns should be considered separately from whole-plant fresh mass. Although the P2C2 treatment showed the highest reported means for several vegetative variables, fresh mass did not respond significantly to treatment in the original analysis. Consequently, the results do not demonstrate increased fresh yield or productivity. Related studies have reported variable relationships among growth traits, chlorophyll status, and harvested biomass depending on fertilizer



management (Lukmanasari, 2022; Safitri *et al.*, 2025; Seran *et al.*, 2025).

Root volume deserves particular caution. The original table contains values within a narrow interval (81.50–82.75 cm³), and two marginal means are inconsistent with the displayed treatment-cell means. The significance letters have been preserved as reported, but inference on root responses should be checked against the original displacement measurements, measurement precision, and full ANOVA/DMRT output before publication.

The principal limitation is incomplete documentation of fertilizer preparation and characterization, liquid application volume, blocking and randomization, sample-selection procedures, and replicate-level statistical results. The publication-ready interpretation therefore emphasizes observed numerical means and reported statistical classifications without creating missing information. These clarifications are needed to establish reproducibility and to evaluate the agronomic significance of the reported effects.

CONCLUSION

Within the treatment levels studied, the source analysis reported a compost effect on leaf number and root volume and interactions between LOF concentration and compost rate for plant height, leaf length, leaf width, and estimated leaf area. The combination of 200 mL/L LOF and 200 g compost per polybag showed the highest numerical means for those four vegetative variables, but overlapping DMRT groupings for several traits do not support calling it uniquely optimal. Chlorophyll meter readings and fresh mass did not differ significantly according to the reported analysis; therefore, improved crop productivity was not demonstrated. The interpretation, particularly for root volume, should be finalized after confirmation of the original

means, statistical output, and application details.

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