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Effect of coffee husk compost and liquid organic fertiliser on growth and yield of *Capsicum annuum* L. var. *grossum*

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Abstract: This study evaluates the synergy between coffee husk compost and Herbafarm liquid organic fertiliser (LOF) as a sustainable alternative to improve growth and yield. The research used a randomised complete block design (RCBD) with two factors: coffee husk compost (0, 80, 90, and 100 g per 10 kg of soil) and Herbafarm LOF (0, 4, 8, and 12 $cm^3 \cdot dm^{-3}$). The compost was prepared over an eight-week period. The process involved chopping coffee husks (600 $g \cdot kg^{-1}$) and mixing them with cow dung (300 $g \cdot kg^{-1}$) and bran (100 $g \cdot kg^{-1}$). The chemical composition of both treatments was analysed prior to application. The following parameters were analysed: plant height, number of leaf, leaf area, stem circumference, total branches, total fruits per plant, harvested fruit weight. Data were analysed using analysis of variance (ANOVA). To ensure validity, assumptions of normality and homogeneity of variance were verified using SPSS software. The results specifically demonstrate that the combination of 100 g compost and 8 $cm^3 \cdot dm^{-3}$ LOF significantly increased leaf area to 88.64 mm^2, while 90 g compost combined with 8 $cm^3 \cdot dm^{-3}$ LOF resulted in the highest stem circumference of 4.37 cm. Optimal yields were achieved with 90 g of coffee husk compost, resulting in a fruit weight of 75.47 g per plant. These findings propose a sustainable strategy to utilise coffee husk to reduce environmental pollution and boosting horticultural productivity.

Keywords: coffee husk compost, liquid organic fertiliser (LOF), organic soil amendment, red bell pepper yield, sustainable agriculture

INTRODUCTION

The development of red bell pepper (*Capsicum annuum* L. var. *grossum*) cultivation in Indonesia has been suboptimal, despite its significant export value. This is attributed to farmers' limited knowledge of appropriate cultivation techniques. Based on data from 2014 to 2017, the highest average red bell pepper production was recorded in West Java, East Java, and Bali Provinces. West Java is Indonesia's main production centre, with an average of 4,013.25 Mg from 2014 to 2017, followed by East Java with 1,986 Mg and Bali with 243.25 Mg (BPS, no date b).

Red bell pepper production in Central Sulawesi declined sharply, from 188 Mg in 2020 to just 65 Mg in 2024, primarily due to land degradation caused by continuous use of inorganic fertilisers. While coffee husks are abundant as a by-product, they are often mismanaged, leading to environmental pollution and phytotoxicity if applied raw. There is a critical research gap in optimising the conversion of this waste into high-quality compost specifically for bell pepper cultivation in tropical regions. This study provides a novel approach by combining nutrient-rich coffee husk compost with Herbafarm LOF, which contains beneficial microbes such as *Azotobacter* sp. and *Pseudomonas* sp. to synergistically improve nutrient uptake (BPS, no date a).

Coffee husk waste, a primary by-product of coffee processing, poses significant environmental concerns when disposed of improperly. The accumulation of husks in open environments leads to the release of unpleasant odours and creates favourable conditions for the proliferation of pests and pathogenic microorganisms (Cruz *et al.*, 2020). According to Munawar (2011), soil fertility is the capacity of soil to continuously supply essential nutrients in forms and quantities readily available to plants, thereby supporting sustainable growth and optimal production.

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to land degradation caused by continuous use of inorganic fertilisers. While coffee husks are abundant as a by-product, they are often mismanaged, leading to environmental pollution and phytotoxicity if applied raw. There is a critical research gap in optimising the conversion of this waste into high-quality compost specifically for bell pepper cultivation in tropical regions. This study provides a novel approach by combining nutrient-rich coffee husk compost with Herbafarm LOF, which contains beneficial microbes such as *Azotobacter* sp. and *Pseudomonas* sp. to synergistically improve nutrient uptake (BPS, no date a).

Coffee husk can be effectively composted either alone or in combination with cow dung and fruit and vegetable wastes, resulting in changes in microbial communities and improvements in compost quality (Shemekite *et al*., 2014). Additionally, coffee husks contain considerable amounts of caffeine and polyphenolic compounds, which are known to exert phytotoxic effects on plant growth and germination when applied directly to the soil without prior composting (Pandey *et al*., 2000). The high lignocellulosic content of coffee husks also contributes to their slow biodegradability, resulting in persistent solid waste that may disrupt the soil microbial balance (Murthy and Naidu, 2012). Traditional wet coffee processing facilities can adversely affect downstream ecosystems, leading to considerable ecological degradation and potentially serious health implications for surrounding populations (Dadi *et al*., 2018). These issues underscore the urgent need for sustainable waste management practices. Composting or other forms of bioconversion can help mitigate the environmental footprint of coffee production.

Red bell pepper seeds cultivation is greatly influenced by cultivation techniques and planting media conditions. One effort that can be made to increase the growth and yield is by combining coffee fruit peel waste compost in the planting media and adding Herbafarm liquid organic fertiliser.

The application of coffee husk waste and liquid organic fertiliser is expected to increase growth and yield. Hence, this study examines the effects of coffee husk waste and Herbafarm liquid organic fertiliser effect on the red bell pepper (*Capsicum annum* var. *grossum* L.) growth and yield.

MATERIALS AND METHODS

The study was conducted in the screen house of the Faculty of Agriculture, Tadulako University (latitude 0°50'11.15" S, longitude 119°53'39.0" E), Palu, Central Sulawesi, from February to August 2024. The tools used included hoes, 40 cm × 50 cm polybags, seedling trays, rulers, measuring tapes, cameras, label paper, plastic sacks, sprayers, measuring cups, scales, and a leaf area meter (Delta-T MK2 Leaf Area Meter, UK), along with stationery. The materials used include red bell pepper seeds, soil, coffee husk waste, bran, Herbafarm liquid organic fertiliser, molasses, water, and Effective Microorganisms (EM) as a decomposer.

This study was conducted using a two-factor factorial arrangement within a randomised complete block design (RCBD) following the procedure described by Gomez and Gomez (1984). The blocking was based on plant height variability, and the experiment involved two treatment factors. The first factor was the application rate of coffee husk compost, consisting of four levels: K0 (no compost application), K1 (80 g coffee husk compost per 10 kg of soil), K2 (90 g of coffee husk compost per 10 kg of soil), and K3 (100 g of coffee husk compost per 10 kg of soil). The second factor was the concentration of Herbafarm liquid organic fertiliser, which comprised four levels: P0 (without liquid organic fertiliser), P1 (4 cm^3 Herbafarm liquid organic fertiliser per dm^3 of water), P2 (8 cm^3 Herbafarm liquid organic fertiliser per dm^3 of water), and P3 (12 cm^3 of Herbafarm liquid organic fertiliser dm^3 of water). The combination of these factors resulted in 16 treatment combinations. Each treatment was replicated three times, yielding a total of 48 experimental units. Every experimental unit consisted of five plants.

Compost preparation: the composted coffee husk was prepared over an 8-week period. The process involved chopping husks (600 $g \cdot kg^{-1}$) and mixing them with cow dung (300 $g \cdot kg^{-1}$) and bran (100 $g \cdot kg^{-1}$). The mixture reached decomposition maturity when it became blackish-brown and odourless, achieving a final C:N ratio of 19.54.

Fertiliser and soil analysis: the chemical composition of both treatments was analysed prior to application:

1) coffee husk compost: C-organic = 387 $g \cdot kg^{-1}$, Ntot = 19.8 $g \cdot kg^{-1}$, Ptot = 1.3 $g \cdot kg^{-1}$, K = 25.7 $g \cdot kg^{-1}$.
2) Herbafarm LOF: C-organic = 154.4 $g \cdot kg^{-1}$, N = 16.6 $g \cdot kg^{-1}$, P = 17.6 $g \cdot kg^{-1}$, K = 18.7 $g \cdot kg^{-1}$. It is enriched with microbes such as *Azotobacter* and *Pseudomonas* sp.
3) soil baseline: the soil at the study site was classified as Inceptisol, indicating a relatively young soil with limited profile development; it contained Ntot (3.3 $g \cdot kg^{-1}$), C-organic (15.6 $g \cdot kg^{-1}$), suggesting moderate organic matter content; the available P content (41.01 ppm) was high, while exchangeable K (0.253 cmol (+)$\cdot kg^{-1}$) was within a moderate range; soil reaction showed a pH of 6.46 (KCl) and 7.13 (H_2O), indicating slightly acidic to neutral conditions; overall, these properties reflect moderate soil fertility, with adequate phosphorus availability but relatively low organic carbon content.

Observation parameters:

- plant height (cm) was determined by measuring from the stem base to the highest leaf tip which were taken at 15, 30, 45, 60, and 75 DAP (days after planting);
- number of leaf: total leaf per plant was calculated by counting each plant's total number; measurements were taken at 15, 30, 45, 60, and 75 DAP;
- leaf area (mm) was measured using a CI-202 Portable Laser Leaf Area Meter at the end of the study;
- stem circumference (cm) was determined by measuring the area using a meter tape starting 1 cm from the ground surface which was carried out at 15, 30, 45, 60, and 75 DAP;
- total branches that grew was counted at the end of the observation;
- total fruits per plant was calculated for five harvests and averaged;
- harvested fruit weight (g) was calculated by weighing all harvested fruits per plant across five harvests and then averaging the results.

Statistical analysis: data were analysed using analysis of variance (ANOVA). To ensure the validity of the analysis, the assumptions of normality and homogeneity of variance were verified using SPSS software (version 26.0, IBM Corp, Armonk, NY, USA). Significant differences among treatment means were further evaluated using the honestly significant difference (*HSD*) test at $p < 0.05$.

RESULTS

The study revealed an interaction between coffee husk treatment (K) and Herbafarm liquid organic fertiliser (P) on for leaf area and stem circumference at 30 and 75 days after planting (DAP) (Tab. 1).

Table 1. The effect of composting coffee fruit bark waste (K) and liquid organic fertiliser (P) and their interaction (K × P) on the composted coffee husk and liquid organic fertiliser

No.	Observation parameter	Age (DAP)	Treatment effect (*F*-value calculated using ANOVA)		
			K	P	K × P
1	plant height (cm)	15	2.00ns	0.51ns	0.45ns
		30	2.00ns	1.67ns	1.47ns
		45	2.14ns	4.53**	0.86ns
		60	1.74ns	6.61**	0.84ns
		75	1.38ns	4.47**	0.71ns
2	number of leaves	15	1.49ns	0.67ns	0.58ns
		30	4.62**	3.62*	1.19ns
		45	7.36**	4.44*	1.63ns
		60	1.96ns	3.69*	0.69ns
		75	2.22ns	3.59*	0.97ns
3	leaf area (mm)	75	12.28**	19.02**	9.59**
4	rod circumference (cm)	15	8.37**	1.21ns	0.45ns
		30	0.28ns	3.62*	2.93*
		45	1.44ns	0.86 ns	2.11ns
		60	7.49**	2.97*	2.18ns
		75	7.67**	1.04ns	3.03**
5	number of branches		3.31*	0.18ns	0.94ns
6	number of fruits per plant		6.44**	2.51ns	2.17ns
7	fresh fruit weight (g)		13.19**	7.18**	1.16ns

Note: K (2.90), P (2.90), K × P (2.19), $p < 0.05$; K (4.46), P (4.46), K × P (3.02), $p < 0.01$.
Explanations: ns = not significant, * $p < 0.05$, ** $p < 0.01$, DAP = day after planting. K = coffee bean husk compost, P = Herbafarm liquid organic fertiliser, K × P = interaction of composted coffee husk with Herbafarm liquid organic fertiliser.
Source: own study.

The results of the post-hoc test indicated significant differences among treatments (*HSD*, $p < 0.05$) as shown in Table 2. At 45 days after planting, the tallest pepper plants (18.03 cm) were observed under the P_2 treatment. This value was not significantly different from P_1 and P_3, whereas the control treatment (P_0), which did not receive liquid organic fertiliser, produced a lower plant height of 14.63 cm. At 60 days after planting, the highest plant height (21.93 cm), is noted again in P_2; it was statistically similar to P_1 and P_3. The control treatment (P_0) without liquid organic fertiliser resulted in a plant height of 18.13 cm. By 75 days after planting, the greatest plant height (25.77 cm) was still recorded in P_2. Results for treatments P_1 and P_3 were comparable, while the P_0 treatment (without liquid organic fertiliser) produced a lower plant height (21.58 cm).

Table 2. Plant height (cm) of red bell pepper at 45, 60, and 75 days after planting (DAP) on the application of liquid organic fertiliser

Treatment	Plant height (cm) at age		
	45 DAP	60 DAP	75 DAP
P_0	14.63^{a}	18.13^{a}	21.58^{a}
P_1	16.59^{ab}	20.05^{ab}	24.60^{ab}
P_2	18.03^{b}	21.93^{b}	25.77^{b}
P_3	18.02^{b}	21.58^{b}	25.02^{ab}
***HSD* (p < 0.05)**	**2.87**	**2.70**	**3.49**

Explanations: P_0 = without liquid organic fertiliser, P_1 = 4 cm^3 Herbafarm liquid organic fertiliser per dm^3 of water, P_2 = 8 cm^3 Herbafarm liquid organic fertiliser per dm^3 of water, P_3 = 12 cm^3 Herbafarm liquid organic fertiliser per dm^3 of water; means in the same column sharing identical letters indicate no significant difference based on Tukey's honestly significant difference (HSD) test ($p < 0.05$).
Source: own study.

ANOVA revealed that compost application significantly influenced leaf number at 30 and 45 days after planting (DAP), while the interaction between compost and liquid fertiliser treatments showed no significant effect at 15, 30, 45, 60, and 75 DAP. The HSD test $p < 0.05$ (Tab. 3) indicated that treatment K_1 produced the highest leaf number at 30 DAP (15.25 leaves), which was statistically comparable to K_2 and K_3 but significantly higher than K_0. At 45 DAP, K1 again resulted in the highest leaf number (19.58 leaves), with no significant difference from K_2 and K_3. In contrast, K_0 consistently recorded the lowest leaf numbers, including 11.42 leaves at 45 DAP and 15.00 leaves at 60 DAP.

Table 3. Number of red bell pepper plant leaf at 30 and 45 days after planting (DAP) on the application of composted coffee husk

Treatment	Number of leaf at	
	30 DAP	45 DAP
K_0	11.42^{a}	15.00^{a}
K_1	15.25^{b}	19.58^{b}
K_2	13.92^{ab}	18.25^{b}
K_3	13.17^{ab}	17.17^{ab}
***HSD* (p < 0.05)**	**2.99**	**2.87**

Explanations: K_0 = no compost application, K_1 = 80 g coffee husk compost per 10 kg of soil, K_2 = 90 g coffee husk compost per 10 kg of soil, K_3 = 100 g coffee husk compost per 10 kg of soil; means in the same column sharing identical letters indicate no significant difference based on Tukey's honestly significant difference (HSD) test ($p < 0.05$).
Source: own study.

Based on the HSD test at significance level of $p < 0.05$, the highest leaf number at 30 DAP (14.75 leaves) was observed under treatment P_2, which was statistically similar to P_1 and P_3 but higher than that of P_0 (11.50 leaves) – Table 4. At 45 DAP, P_3 showed the highest value (19.00 leaves), which was not significantly different from P_1 and P_2, but significantly higher

Table 4. Number of red bell pepper plant leaf at 30, 45, 60, and 75 days after planting (DAP) on the application of liquid organic fertilise

Treatment	Number of leaf at			
	30 DAP	45 DAP	60 DAP	75 DAP
P_0	11.50^{a}	15.42^{a}	19.92^{a}	24.50^{a}
P_1	14.17^{ab}	17.92^{ab}	23.42^{ab}	27.83^{ab}
P_2	14.75^{b}	17.67^{ab}	22.67^{ab}	28.58^{b}
P_3	13.33^{ab}	19.00^{b}	23.67^{b}	28.33^{ab}
***HSD p* < 0.05**	**2.99**	**2.87**	**3.60**	**4.03**

Explanations as in Tab. 2.
Source: own study.

than P_0. A similar trend was observed at 60 DAP, where P_3 recorded the greatest leaf number (23.67 leaves), comparable to P_1 and P_2 but significantly exceeding P_0. At 75 DAP, P_2 resulted in the highest leaf number (28.58 leaves), which did not differ significantly from P_1 and P_3 but was significantly higher than P_0. Overall, P_1 and P_2 exhibited comparable responses, while P_0 consistently showed significantly lower leaf development.

ANOVA results indicated a significant interaction between coffee husk compost and Herbafarm liquid organic fertiliser treatments on leaf area at 75 days after planting. The HSD test at $p < 0.05$ showed that the K_3P_2 treatment (100 g of compost per 10 kg of soil combined with 8 $cm^3 \cdot dm^{-3}$ Herbafarm) produced the highest leaf area (88.64 cm^2), which differed significantly from the other treatments (Tab. 5).

Table 5. Leaf area (cm^2) of red bell pepper plants at 75 days after planting (DAP) on the application of composted coffee husk and liquid organic fertiliser

Treat-ment	Leaf area at				*HSD* ($p < 0.05$)
	P_0	P_1	P_2	P_3	
K_0	$^{a}41.73^{q}$	$^{a}36.73^{p}$	$^{a}34.30^{p}$	$^{b}56.83^{q}$	7.24
K_1	$^{a}24.84^{p}$	$^{b}56.54^{r}$	$^{b}55,20^{q}$	$^{b}57.11^{q}$	
K_2	$^{a}41.49^{q}$	$^{a}47.40^{q}$	$^{a}48.97^{q}$	$^{a}46.94^{p}$	
K_3	$^{a}40.99^{q}$	$^{a}47.07^{q}$	$^{c}88.64^{r}$	$^{b}60.13^{q}$	
HSD **($p < 0.05$)**	**7.24**				

Explanations: P_0, P_1, P_2, P_3 as in Tab. 2, K_0, K_1, K_2, K_3 as in Tab. 3; means sharing the same letters within a column (p, q) or row (a, b) indicate no significant difference based on Tukey's honestly significant difference (HSD) test ($p < 0.05$).
Source: own study.

Analysis of variance (ANOVA) demonstrated a statistically significant interaction effect between coffee husk waste compost and Herbafarm liquid organic fertiliser on stem circumference at 75 days after planting. Subsequent HSD testing at $p < 0,05$ (Tab. 6) showed that the K_2P_2 treatment (90 g compost per 10 kg soil combined with 8 $cm^3 \cdot dm^{-3}$ Herbafarm) resulted in the greatest mean stem circumference (4.37 cm), significantly exceeding that of all other treatment combinations.

Analysis of variance (ANOVA) indicated that coffee husk waste treatment significantly affected the number of branches per pepper plant at 75 days after planting. The HSD test at the 5% significance level (Tab. 7) revealed that the K_2 treatment produced the highest mean number of branches (3.53 branches per plant). This value was not significantly different from K_3, but was significantly higher than those of K_1 and K_0.

Table 6. Stem circumference (cm) of red bell pepper plants at 75 days after planting (DAP) on the application of composted coffee husk and liquid organic fertiliser

Treatment	P_0	P_1	P_2	P_3	*HSD* ($p < 0.05$)
K_0	$^{a}3.43^{p}$	$^{ab}3.53^{p}$	$^{ab}3.70^{q}$	$^{b}3.78^{pq}$	**0.29**
K_1	$^{b}3.88^{q}$	$^{b}3.92^{q}$	$^{a}3.18^{p}$	$^{b}3.73^{p}$	
K_2	$^{a}3.83^{q}$	$^{a}4.05^{q}$	$^{b}4.37^{r}$	$^{a}4.09^{r}$	
K_3	$^{b}3.82^{q}$	$^{b}3.92^{q}$	$^{a}3.52^{q}$	$^{ab}3.75^{pq}$	
HSD **($p < 0.05$)**	**0.29**				

Explanations: K_0, K_1, K_2, K_3 as in Tab. 3; means sharing the same letters within a column (p, q) or row (a, b) indicate no significant difference based on Tukey's honestly significant difference (HSD) test ($p < 0,05$).
Source: own study.

Table 7. Number of red bell pepper plant branches at 75 days after planting (DAP) on the application of composted coffee husk

Treatment	Number of branches
K_0	1.32^{a}
K_1	2.87^{b}
K_2	3.53^{c}
K_3	3.03^{bc}
HSD **($p < 0.05$)**	**0.65**

Explanations as in Tab. 3.
Source: own study.

Analysis of variance (ANOVA) showed that coffee husk waste compost treatment significantly affected the total number of fruits per plant. The HSD test at the 5% significance level (Tab. 8) indicated that the K_2 treatment produced the highest mean number of fruit (2.70 fruits per plant). This value was not significantly different from K_3, but was significantly higher than those of K_1 and K_0.

Table 8. Average number of red bell pepper plant fruits on the application of composted coffee husk

Treatment	Number of fruits
K_0	2.05^{a}
K_1	2.28^{a}
K_2	2.70^{b}
K_3	2.35^{ab}
HSD **($p < 0.05$)**	**0.41**

Explanations as in Tab. 3.
Source: own study.

Analysis of variance (ANOVA) revealed that coffee husk compost treatment had a highly significant effect on fruit weight per plant. Tukey's HSD test at $p < 0.05$ (Tab. 9) showed that the K_2 treatment produced the highest mean fruit weight (75.47 g per plant). This value was significantly different from that of K_0, but not significantly different from that of K_1 and K_3.

Table 9. Average fruit weight (g) of red bell pepper plants on the application of composted coffee husk

Treatment	Fruit weight (g)
K_0	60.12^a
K_1	65.78^{ab}
K_2	75.47^b
K_3	73.70^b
***HSD* (*p* < 0.05)**	**12.75**

Explanations as in Tab. 3.
Source: own study.

Analysis of variance (ANOVA) demonstrated that Herbafarm liquid organic fertiliser treatment had a highly significant effect on fruit weight per plant. The HSD test at $p < 0.05$ (Tab. 10) indicated that the P_2 treatment produced the highest mean fruit weight (74.03 g per plant). This value was significantly different from that of the control treatment (P_0), but not significantly different from those of P_1 and P_3.

Photographic documentation was kept during the research (Fig. 1).

Table 10. Average fruit weight (g) of red bell pepper plants on the application of liquid organic fertilise

Treatment	Fruit weight (g)
P_0	61.50^a
P_1	70.33^b
P_2	74.03^b
P_3	69.20^b
***HSD* (*p* < 0.05)**	**7.55**

Explanations as in Tab. 2.
Source: own study.

DISCUSSION

THE EFFECT OF COMPOSTED COFFEE HUSK

Nutrient analysis conducted by Dzung and Khanh (2013) demonstrated that coffee husk contains 12.7 $g \cdot kg^{-1}$ N, 0.6 $g \cdot kg^{-1}$ P, and 24.6 $g \cdot kg^{-1}$ K, suggesting that this agricultural by-product has considerable potential for use as a potassium-rich organic amendment. Coffee husk waste represents a promising alternative to inorganic fertilisers because of its valuable nutrient composition and agronomic benefits. Through appropriate processing techniques, coffee husk waste can be transformed into an effective organic fertiliser that improves soil fertility and enhances the soil's ability to sustain plant growth and increase crop productivity (Putri *et al.*, 2025). Prasetyo (2014) also reported that optimal efficiency in nutrient use efficiency is achieved when nutrients are supplied in sufficient quantities to meet the needs of plants.

The application of 80 g of compost per 10 kg of coffee fruit bark waste produces the highest number of leaves and is different from no composting. Nitrogen (N) from both sources enhanced chlorophyll synthesis and photosynthesis, leading to higher leaf counts (Sutrisna and Surdianto, 2014). According to Sulistyowati (2011), an increase in leave number enhances photosynthate production through photosynthesis. These photosynthates are then distributed throughout the plant, promoting the growth of leaves and stems. Coffee husk waste is a valuable source of macronutrients, including nitrogen, phosphorus, and potassium, which play important roles in enhancing soil fertility and supporting plant growth by stimulating the development of roots, stems, and leaves (Afrizon, 2014).

The application of 90 g of coffee husk compost per 10 kg of soil produced the highest fruit weight (75.47 g) compared to the control treatment without composting. This response may be attributed to the supply of macronutrients (N, P and K) contained in the coffee bean peel compost, which likely met requirements of pepper plants for optimal fruit production. According to Berlian *et al* (2015), the addition of coffee husk compost to the planting medium significantly improves the growth of chili peppers.

HERBAFARM LIQUID ORGANIC FERTILISER

The results of the study showed that the application of Herbafarm liquid organic fertiliser at 8 cm^3 of Herbafarm liquid organic fertiliser per dm^3 of water affects plant height, number of leaves, leaf area, stem circumference and weight of fresh fruits. The beneficial effects of Herbafarm liquid organic fertiliser on the growth and yield of red bell pepper may be attributed to its content of N-binding active ingredients *Azotobacter* sp., phosphate-solubilising bacteria *Pseudomonas* sp., *Aspergillus, Bacillus, Penicillium*, and *Lactobacillus* sp., as well as cellulolytic bacteria. Herbafarm also contains microbes that decompose organic materials and provide nutrients to plants (PT. Sido Muncul Pupuk Nusantara, no date). During the generative stage, the availability of nutrients supports photosynthesis, leading to the formation of better carbohydrates, which promoted fruit devel-

Fig. 1. Sequence of images during the experiment: 1 – coffee husk waste, 2 – plant height at 60 days after planting (60 DAP), 3 – flowering and fruit set occurred at 60 days after planting (60 DAP), 4 – plants at 75 days after planting (DAP), 5 – fruit dimensions at harvest, 6 – red bell pepper fruits at harvest; source: own study

opment and increases fruit weight per plant (Pranata and Marseno, 2002). The composition of Herbafarm liquid organic fertiliser includes 69.3 g·kg^{-1} organic carbon (C), 22.4 g·kg^{-1} nitrogen (N), 19.1 g·kg^{-1} phosphorus (P), 18.1 g·kg^{-1} potassium (K), 2.6 g·kg^{-1} iron (Fe), 0.03 g·kg^{-1} manganese (Mn), 2.49 ppm copper (Cu), 0.02 g·kg^{-1} zinc (Zn), 1.00 g·kg^{-1} boron (B), and 0.74 ppm cobalt (Co). All of these plant nutrients are essential elements for plants and play a crucial role in supporting optimal growth and productivity (Havlin *et al*., 2005).

EFFECT OF COMPOSTED COFFEE HUSK INTERACTION WITH HERBAFARM LIQUID ORGANIC FERTILISER

The results of statistical analysis showed an interaction between the application of composted coffee husk and liquid organic fertiliser on leaf area and stem circumference. Treatment consisting of 90 g of coffee husk compost per 10 kg of soil and 8 cm^3 of Herbafarm per dm^3 of water liquid organic fertiliser resulted in better growth and yield compared with the other treatments. Organic waste can be effectively utilised as a raw material for compost. Composting reduces the C/N ratio to around 10–12, indicating compost maturity, while also producing compost rich in essential nutrients, including nitrogen, phosphorus, and potassium (Widarti, Wardhini and Sarwono, 2015).

The macronutrient elements nitrogen (N), phosphorus (P), and potassium (K) are the main contributors to plant growth and development through different but complementary plant physiological processes. Nitrogen is essential for chlorophyll synthesis and protein production, thereby directly increasing leaf count and vegetative vigor (Zulaiha *et al*., 2012). Phosphorus facilitates energy transfer through ATP, supporting root development and the transition to the reproductive phase (Jiaying *et al*., 2022). Potassium regulates stomatal opening and osmotic pressure, thereby ensuring efficient photosynthate translocation to developing fruits (Shanwei Wu *et al*., 2023). It also contributed to protein and carbohydrate synthesis and supports the development of stronger plant structures (Advinda, 2018).

Decomposer microorganisms (bacteria and fungi) break down the organic compounds of present in coffee bean husks into plant-available nutrients. The presence of *Azotobacter* and phosphate-solubilising bacteria in Herbafarm enhances the bioavailability of nutrients from the compost through mineralisation, thereby creating a slow-release nutrient system (Brady and Weil, 2008). This synergy enhances the efficiency of NPK utilisation and improves soil fertility. Soil microorganisms contribute to increased fruit number per plant, greater fruit weight, more uniform fruit size, and improved fruit quality, including greater flesh thickness, higher vitamin C content, and increased sweetness. Arbuscular mycorrhizae have also been shown to increase the efficiency of water use and microelements uptake, thereby improving the stability of pepper production, especially under environmental stress conditions

CONCLUSIONS

The study concludes that the application of 90 g of coffee husk compost per 10 kg of soil combined with 8 cm^3 of Herbafarm liquid organic fertiliser per dm^3 of water produced the most beneficial effect on red bell pepper production. This combination resulted in the greatest stem circumference (4.37 cm) and fruit weight (75.47 g), indicating its potential as an effective organic nutrient management strategy for red bell pepper cultivation in Central Sulawesi.

The results of this study also demonstrate that coffee husk, which may pose environmental challenges if improperly managed, can be effectively used to enhance the production of horticultural crops, especially red bell pepper, thereby reducing reliance on chemical fertilisers.

CONFLICT OF INTERESTS

All authors declare that they have no conflict of interests.

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