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PENGARUH PEMBERIAN PUPUK ORGANIK CAIR LIMBAH KULIT NANAS DAN LIMBAH SABUT KELAPA SEBAGAI SUBSTITUSI PARSIAL NUTRISI AB MIX TERHADAP PERTUMBUHAN DAN HASIL TANAMAN KALE (*Brassica oleracea*) PADA SISTEM HIDROPONIK NFT

EFFECT OF GIVING LIQUID ORGANIC FERTILIZER FROM PINEAPPLE PEEL WASTE AND COCONUT HUSK WASTE AS A PARTIAL SUBSTITUTION OF AB MIX NUTRITION FOR PLANT GROWTH AND YIELD KALE (Brassica oleracea) ON SYSTEM NFT HYDROPONICS

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ABSTRAK

Jumlah lahan pertanian di Kota Bandar Lampung mengalami penurunan sekitar 40.15%, yaitu dari 10.435,44 ha menjadi 6.244,62 ha. Budidaya hidroponik menjadi salah satu program urban farming yang banyak dikenal oleh masyarakat karena karakteristik lahan perkotaan yang sangat terbatas. Pemanfataan limbah menjadi pupuk organik cair menawarkan solusi berkelanjutan terhadap masalah limbah pertanian serta dapat meminimalisir volume limbah dan mengurangi pencemaran udara. Penggunaan POC menjadi salah satu inovasi untuk menekan biaya produksi tersebut karena dengan mengurangi biaya pembelian input produksi, potensi margin keuntungan petani dapat meningkat. Di samping itu, pemanfaatan bahan baku lokal untuk produksi POC juga dapat meningkatkan efisiensi biaya distribusi dan memperkuat kemandirian petani dalam mengelola usaha pertanian. Penelitian ini menggunakan Rancangan Acak Lengkap (RAL) dengan total 4 perlakuan nutrisi. Ulangan yang digunakan berjumlah 6 ulangan dengan 24 satuan percobaan. Penelitian menunjukkan bahwa hasil dengan perlakuan terbaik ditunjukkan oleh perlakuan P4 yaitu 75% AB mix + 25 POC kulit nanas dan sabut kelapa. Penggunaan 25% pupuk organik cair kulit nanas dan/atau sabut kelapa dengan 75% AB mix memiliki hasil yang tidak berbeda nyata atau sudah dapat menyamai perlakuan 100% nutrisi AB mix. Hasil persentase perbandingan bobot basah tajuk tanaman kale antara substitusi 25% POC kulit nanas dan/atau sabut kelapa dengan perlakuan 100% AB mix, yaitu 75% AB mix + 25% POC kulit nanas dan sabut kelapa (102,3%), perlakuan 75% AB mix + 25% POC sabut kelapa (99,7%), perlakuan 75% AB mix + 25% POC kulit nanas (79,9%).

KEYWORDS:

AB mix nutrients, kale, liquid organic fertilizer coconut husk, liquid organic fertilizer pineapple peel, NFT hydroponics

ABSTRACT

The amount of agricultural land in Bandar Lampung City has decreased by around 40.15%, from 10,435.44 ha to 6,244.62 ha. Hydroponic cultivation is one of the urban farming programs that is widely known by the public because of the very limited characteristics of urban land. Utilization of waste into liquid organic fertilizer offers a sustainable solution to the problem of agricultural waste and can minimize waste volume and reduce air pollution. The use of LOF is one of the innovations to reduce production costs because by reducing the cost of purchasing production inputs, farmers' potential profit margins can increase. Furthermore, utilizing local raw materials for POC production can also improve distribution cost efficiency and strengthen farmers' independence in managing their agricultural businesses. This study used a completely randomized design (CRD) with a total of 4 nutrient treatments. There were 6 replications with 24 experimental units. The findings of this research suggest that treatment P4 demonstrates the most effective results, namely 75% AB mix + 25 LOF pineapple peel and coconut husk. The use of 25% liquid organic fertilizer pineapple peel and/or coconut husk with 75% AB mix has results that are not significantly different or can match the treatment of 100% AB mix nutrients. The results of the percentage comparison of the wet weight of the kale plant canopy between the substitution of 25% LOF pineapple peel and/or coconut husk with 100% AB mix treatment, namely 75% AB mix + 25% LOF pineapple peel and coconut husk (102,3%), treatment 75% AB mix + 25% LOF coconut husk (99,7%), treatment 75% AB mix + 25% LOF pineapple peel (79,9%).

1. INTRODUCTION

Currently, Indonesia still faces challenges or issues in addressing food security. From 2011 to 2014, the amount of agricultural land in Bandar Lampung City decreased by approximately 40.15%, from 10,435.44 ha to 6,244.62 ha (Bandar Lampung City BPS, 2018). In addressing food security issues, urban agriculture is one solution to increase food availability in sufficient quantities, nutritious, and cost-effective (Ismail and Hartati, 2022).

One program that can be implemented to maintain the quality of life in urban areas is by applying urban farming. One application of urban farming that can be implemented is by applying a hydroponic cultivation system. Hydroponic systems can address several issues, such as limited land availability, poor soil conditions, pest and disease infestations, limited water supply, unpredictable seasons, and inconsistent quality. Hydroponic cultivation can be carried out year-round regardless of the season, resulting in more stable market prices for harvested produce (Andini *et al*., 2021).

In Indonesia, the potential for kale cultivation is quite high because this plant contains nutrients that are good for health, such as sulforaphane, beta-carotene, flavonoids, lutein, and zeaxanthin (Lestari, 2017). Kale has high nutritional value, making it economically valuable at around IDR 45,000 to IDR 50,000 per 200 g. The growing awareness among the public about maintaining a healthy lifestyle by consuming fresh and clean vegetables has led to increasing demand for kale (Tristinandi and Nihayati, 2024).

AB mix nutrients are the primary nutrients and one of the most expensive production costs in hydroponic cultivation. The use of liquid organic fertilizer is one innovation to reduce these production costs (Fitriyatno *et al*., 2012). The utilization of waste into liquid organic fertilizer offers a sustainable solution to agricultural waste issues and can minimize waste volume and reduce air pollution (Aulia *et al*., 2024). Pineapple peel waste has the potential to be developed into useful products with high market value if processed properly (Sutanto and Lubis, 2017). Pineapple waste is easily found around us, such as in markets, fruit stores, and food or beverage vendors. Waste from pineapples can be utilized as raw material in the production of LOF, such as the peel (Permata *et al*., 2019). According to research (Lushyharti, 2021), the nutrient content of pineapple peel LOF consists of Nitrogen (3.34%), Phosphorus (41.49 ppm), Potassium (716.81 ppm), Calcium (118.20 ppm), Magnesium (21.71 ppm), and a C/N ratio of 31.67.

Derivative products from coconut fruit have great potential for development. The coconut fruit processing industry currently focuses solely on the fruit flesh. Byproducts such as coconut husks have not been fully utilized and are still processed traditionally (Mahmudah, 2020). The essential nutrient content in coconut husks can be used by plants as raw material for LOF production. Based on the research results of Daniel *et al*., (2020) the nutrient content of coconut husk MOL shows values of Nitrogen (0.03%), Phosphorus (0.06%), Potassium (0.76%), and Organic Carbon (5.25%).

This study aims to create a treatment that replaces 25% of AB mix nutrients with pineapple peel and/or coconut husk LOF, yielding results comparable to using 100% AB mix regarding growth and yield in kale plants.

2. MATERIALS AND METHOD

2.1 Time and Place

Research was carried out between January and March 2025. The research was conducted at Jl. Teknik 2 Perumahan Griya Kencana Blok C No.17, Kecamatan Rajabasa, Kota Bandar Lampung.

2.2 Tools and Materials

The tools used in this study included plastic boxes, hoses, 10 L jerry cans, 40 L buckets, PVC pipes, PVC fittings, pipe glue, electric drills, hole saws, Ginga 103 water pumps, styrofoam, net pots, rockwool, flannel cloth, skewers, knives, saws, sieves, trays, measuring tapes, 5 L measuring cup, 250 mL measuring cup, pH meter, TDS meter, lux meter, SPAD chlorophyll meter, and oven.

The materials used in this study include Paramudita Nutrient brand AB mix nutrient solution, 4.5 kg of pineapple peel, 4.5 kg of coconut husk, 3 L of molasses, 450 mL of EM4, 18 L of old coconut water, and Indo Seed brand kale seeds.

2.3 Experimental Design

This study employed a completely randomized design (CRD) featuring four nutritional treatments, namely 100% AB mix, 75% AB mix + 25% pineapple peel LOF, 75% AB mix + 25% coconut husk LOF, and 75% AB mix + 25% pineapple peel and coconut husk LOF. The experiment was replicated six times, with 24 experimental units, each containing six plants, resulting in a total population of 144 plants.

This study was conducted through several stages, including the installation of NFT hydroponic systems, kale seed sowing, preparation of AB mix nutrients, preparation of pineapple peel and coconut husk LOF, mixing of treatment nutrient solutions, transplanting, maintenance, and harvesting. The variables examined in the study consisted of plant height, leaf count, width of leaves, length of leaves, stem length of leaves, leaf chlorophyll content, wet crown weight, wet leaf weight, wet trunk weight, dry crown weight, dry leaf weight, and dry trunk weight.

The findings from this study will be succeeded by a homogeneity assessment through Bartlett's test and an additivity evaluation utilizing Tukey's test. Should the assumptions hold true, an analysis of variance along with mean value separation will be conducted through the Least Significant Difference (LSD) test at a 5% significance level.

3. RESULT AND DISCUSSION

The findings indicated that the 100% AB mix treatment resulted in the greatest leaf width, measuring 14.51 cm. (Table 1). This was due to the fact that the photosynthate produced in the 100% AB mix treatment was mostly transferred to the leaves. In contrast, in the 75% AB mix + 25% pineapple peel and coconut husk LOF treatment, photosynthetic products were largely translocated to the apical meristem (stem tip), resulting in higher plant height and leaf number compared to other treatments. A higher number of leaves increases photosynthesis and photosynthetic products. The photosynthetic products produced are used to support plant growth (Restiani, 2015). An increased photosynthesis rate enhances the translocation rate from the source to the sink. The stronger the sink's ability to store sugar, the greater the competition for photosynthetic products (Mastur, 2014).

The results indicate that substituting treatment with 25% LOF made from pineapple peel and/or coconut husk can match the nutrient content produced by 100% AB mix nutrients. This is based on several observed variables showing that treatment with liquid organic fertilizer made from pineapple peel and/or coconut husk yields results that are not significantly different from 100% AB mix nutrients. In this study, kale plants treated with pineapple peel and coconut husk LOF had the highest yield compared to the 100% AB mix nutrient treatment. This is evidenced by the wet weight of the crown obtained from the pineapple peel and coconut husk liquid organic fertilizer treatment, which had a higher value than the 100% AB mix nutrient treatment, at 223.83 g. The wet weight of the crown obtained from the 100% AB mix nutrient treatment only reached 218.78 g (Table 2).

Table 1. Variables Observed in Kale Plants at 6 WAP.

Treatment	Plant Height (cm)	Number of Leaves (leaf)	Leaf Lenght (cm)	Leaf Width (cm)	Leaf Stem Lenght (cm)	Leaf Green Level (unit)
P1	38,81	2,98	21,60	14,51a	9,08	32,36bc
P2	36,71	2,95	22,51	13,88a	9,54	30,07c
P3	40,74	2,99	23,25	13,75ab	10,04	35,21b
P4	40,77	3,06	21,45	12,75b	9,43	41,99a
Average	39,26	2,99	22,20	13,72	9,52	34,91
LSD 5%	-	-	-	1,01	-	3,81

Note: Average values sharing the same letter suggest that the treatments do not differ significantly according to the 5% LSD test. 100% AB Mix (P1), 75% AB Mix + 25% LOF Pineapple Peel (P2), 75% AB Mix + 25% LOF Coconut Husk (P3), and 75% AB Mix + 25% LOF Pineapple Peel and Coconut Husk (P4).

Table 2. Variables Observed in Kale Plants at 6 WAP.

Treatment	Wet Weight of Crown (g)	Wet Weight of Leaves (g)	Wet Weight of Trunk (g)	Dry Weight of Crown (g)	Dry Weight of Leaves (g)	Dry Weight of Trunk (g)
P1	218,78	159,94	58,83a	2,78ab	2,66ab	0,50
P2	175,00	133,00	42,00b	2,64b	2,49b	0,57
P3	218,28	155,17	63,11a	2,81ab	2,67ab	0,68
P4	223,83	161,39	62,44a	2,96a	2,85a	0,62
Average	208,97	152,38	56,60	2,80	2,67	0,59
LSD 5%	-	-	13,90	0,18	0,18	-

Note: Average values sharing the same letter suggest that the treatments do not differ significantly according to the 5% LSD test. 100% AB Mix (P1), 75% AB Mix + 25% LOF Pineapple Peel (P2), 75% AB Mix + 25% LOF Coconut Husk (P3), and 75% AB Mix + 25% LOF Pineapple Peel and Coconut Husk (P4).

The research results showed that the 25% substitution of pineapple peel liquid organic fertilizer and the 25% substitution of pineapple peel and coconut husk liquid organic fertilizer produced the highest values in almost all variables. This is because the LOF used in this study utilized coconut water as a solvent. One of the benefits of coconut water is its function as a natural plant growth regulator (PGR) that can promote plant development (Mergiana *et al*., 2021).

The research results showed that the treatment of 75% AB mix + 25% LOF pineapple peel had the lowest values across all observed variables. This is due to the pH value in the nutrient tank often decreasing (Table 4). This decrease in pH is influenced by the main raw material of the LOF used, which is pineapple peel. Pineapple peel contains a high amount of citric acid, accounting for 78% of the total acid content (Irfandi, 2005). Analysis of nutrient content in pineapple peel liquid organic fertilizer conducted at the BSIP Natar laboratory showed that the fertilizer has an acidic pH of 3.52. The increase in pH during LOF fermentation is due to microbial activity converting organic acids into simpler compounds such as carbon dioxide, ammonia, and methane (Kurniawan *et al*., 2022). The relationship between fermentation duration and pH value is not always linear because pH depends on the amount of acid produced by microorganisms. The longer the fermentation, the more carbohydrates microorganisms utilize, which can cause pH to decrease due to increased lactic acid production (Kusumadewi *et al*., 2019).

The research results show that treatments with 25% AB mix substitution with pineapple peel LOF and/or coconut husk yield results that are not significantly different from the 100% AB mix treatment in terms of wet weight of the crown (Table 2). However, the wet weight of the crown produced by treatments P3 and P4 was higher than that of the 100% AB mix treatment. This is because the nutrient concentration used in treatment P1 was higher than that of the 25% substitution treatment with pineapple peel LOF and/or coconut husk (Table 3).

Table 3. Observation Data on Nutrient Solution Concentration.

Treatment	PPM			
	3 WAP	4 WAP	5 WAP	6 WAP
P1	1303	1401	1506	1726
P2	981	1079	1157	1287
P3	999	1080	1149	1290
P4	1000	1069	1146	1283

Note: 100% AB Mix (P1), 75% AB Mix + 25% LOF Pineapple Peel (P2), 75% AB Mix + 25% LOF Coconut Husk (P3), and 75% AB Mix + 25% LOF Pineapple Peel and Coconut Husk (P4).

Table 4. Observation Data of Nutrient Solution pH.

Treatment	pH			
	3 WAP	4 WAP	5 WAP	6 WAP
P1	6,08	5,79	6,09	6,01
P2	5,67	5,46	5,30	5,64
P3	5,93	6,06	5,99	5,98
P4	5,76	5,71	5,91	6,23

Note: 100% AB Mix (P1), 75% AB Mix + 25% LOF Pineapple Peel (P2), 75% AB Mix + 25% LOF Coconut Husk (P3), and 75% AB Mix + 25% LOF Pineapple Peel and Coconut Husk (P4).

According to the research by Fitri *et al*., (2021) the application of AB mix at 1500 ppm on pakcoy from the beginning of planting resulted in higher wet weight compared to the application of AB mix at 500 ppm. However, the AB mix 1500 ppm treatment yielded the lowest dry weight, while the AB mix 500 ppm treatment yielded the highest dry weight. The treatment using AB mix at 1500 ppm resulted in plants with higher water content compared to their photosynthesis output. This occurred because nutrients at a concentration of 1500 ppm precipitated, making them difficult for the roots to absorb (Karoba *et al*., 2015).

The results showed that the treatment of 75% AB mix + 25% LOF coconut husk and the treatment of 75% AB mix + 25% LOF pineapple peel and coconut husk produced the highest leaf greenness levels, namely 35.21 and 41.99 (Table 1). This is due to the relatively high ppm values in the 100% AB mix treatment, ranging from 1300 to 1700 ppm (Table 3). The 75% AB mix + 25% LOF pineapple peel treatment had a lower pH compared to the other treatments, ranging from 5.3 to 5.6 (Table 4).

According to Kartiko and Yama (2020), the use of AB mix at a concentration of 1000 ppm can supply adequate N and Mg for chlorophyll production. Nutrient application with adequate N and Mg content can support optimal plant growth in chlorophyll synthesis. The presence of both nutrients causes an increase in the amount of chlorophyll formed in the leaves. According to Mas'ud (2009), the application of nutrients at high concentrations can damage chloroplast structure and cause disruption of the thylakoid membrane system in chloroplasts. Based on the research by Andika *et al*., (2020) low pH can reduce chlorophyll content, which disrupts the photosynthesis process. Chlorophyll is also highly susceptible to color changes triggered by temperature, pH, and light. Under high pH (alkaline) and low temperature conditions, chlorophyll becomes more stable. Under low pH (acidic) and high temperature conditions, chlorophyll is easily degraded into pheophytin compounds (Riansyah *et al*., 2021). Chlorophyll is the primary pigment in plants that contributes to photosynthesis, which is aided by the sun. This photosynthesis process will produce carbohydrates and energy, which will be converted into more complex compounds (Lawendatu *et al*., 2020).

The color of a leaf is among the elements considered when evaluating its quality. Good leaf color is characterized by the presence of chlorophyll, which causes the leaf to appear green (Haryati and Permadi, 2015). The chlorophyll content at the base of the leaf will differ from that in the middle, edges, and tips of the leaf. Variations in chlorophyll content in leaves will result in differences in leaf color. The leaf will appear greener with an increase in chlorophyll content (Istri and Dharmadewi, 2022).

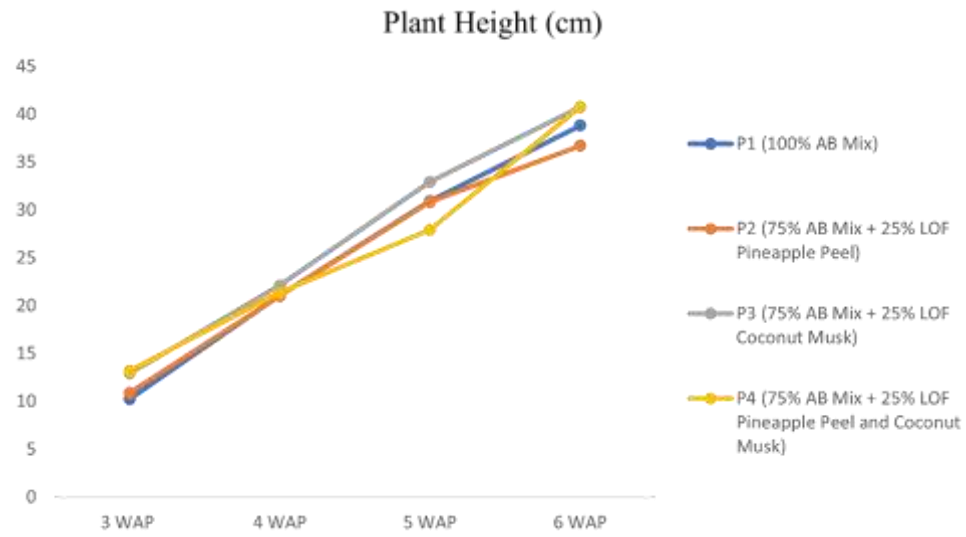


Figure 1. Height growth of kale plants at 3-6 weeks after planting (WAP).

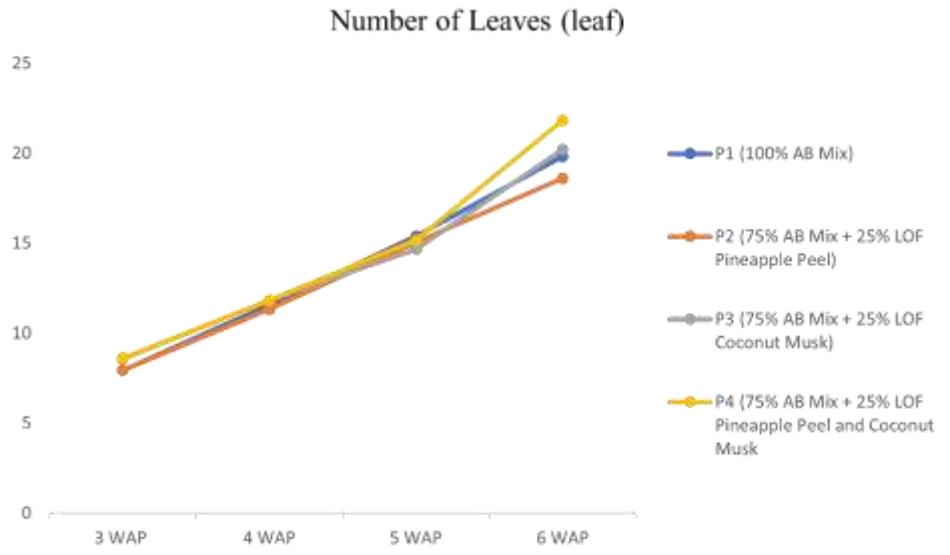
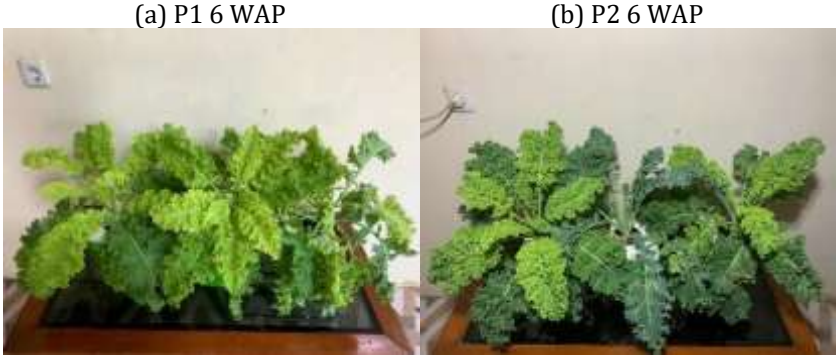


Figure 2. Growth of kale leaves at 3-6 weeks after planting (WAP).

Plant height and leaf number are influenced by internal and external factors. Internal factors consist of hormones and genes. External element include of water, light, nutrients, temperature, and humidity. These factors play a significant role in the process of photosynthesis and biomass formation. An increase in leaf number will increase the photosynthetic capacity produced (Previensari *et al*., 2020). Figures 1 and 2 indicate a rise in the height of kale plants and an increase in leaf count from 3 WAP to 6 WAP.

Figure 3 displays the outcomes of all treatments on kale plants at 6 WAP. The visual characteristics of all treatments show that treatment P2 exhibits a leaf color that is yellower than those of the other treatments. In contrast, treatment P4 exhibited a greener leaf color than the other treatments. Treatment P3 displayed a tendency for yellow leaf coloration; however, the yellow hue was not consistent among all leaves, in contrast to treatment P2. Treatment P1 leaned towards a light green leaf color, whereas treatment P4 leaned towards a dark green leaf color.

(a) P1 6 WAP (b) P2 6 WAP



(c) P3 6 WAP (d) P4 6 WAP

Figure 3. Visual appearance of kale plants grown with 100% AB Mix (P1), 75% AB Mix + 25% LOF Pineapple Peel (P2), 75% AB Mix + 25% LOF Coconut Husk (P3), and 75% AB Mix + 25% LOF Pineapple Peel and Coconut Husk (P4) at 6 weeks after planting (WAP).

Chlorophyll is beneficial for plants in identifying their own health. The health condition of a plant will influence the level of fertilization to be applied (Arifah *et al*., 2019). Green leaves indicate a more effective photosynthesis process compared to green leaves with a yellowish tint (Rahayu *et al*., 2023). This difference is due to the photosynthesis process, chloroplast structure, and pigment content within the leaves. Plants with green leaves that have a yellowish tint exhibit differences in chloroplast structure, characterized by a reduced number of grana. This impairs the optimal functioning of photosynthesis, leading to a decrease in chlorophyll content. Additionally, plant growth is hindered, and the leaves gradually turn yellow due to the reduced photosynthetic process (Wang *et al*., 2017).

4. CONCLUSIONS

The use of 25% liquid organic fertilizer made from pineapple peel and/or coconut husk mixed with 75% AB mix resulted in no significant difference or was comparable to the treatment using 100% AB mix nutrients. The wet weight production of kale plant tops using 75% AB mix + 25% LOF made from pineapple peel and coconut husk has a ratio of 102.3% compared to 100% AB mix nutrients. The application of 75% AB mix + 25% LOF from coconut husks had a ratio of 99.7% compared to 100% AB mix nutrient. The application of 75% AB mix + 25% LOF from pineapple peel had a ratio of 79.9% compared to the 100% AB mix treatment. The treatment of 75% AB mix + 25% pineapple peel and coconut husk LOF produced the highest growth and yield of kale plants. This is based on several variables, including plant height, leaf green level, number of leaves, wet weight of leaves, wet weight of crown, dry weight of leaves, and dry weight of crown.

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