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Coconut Husks and Eggshells Liquid Organic Fertilizer's Effect on The Growth and Calcium Levels of Kale

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ABSTRACT

Kale (*Brassica oleracea var. achepala*) is an essential vegetable for human development due to its calcium levels. Lack of hares in the soil is the cause of the decline in kale production. The purpose of this study was to test eggshell and coconut husk liquid organic fertilizers for kale plant growth and calcium levels. The research was conducted at the green house of Biology Education, FKIP UMS. Liquid organic fertilizer dosage (P1 = 100 ml and P2 = 150 ml) and time intervals (W1 = 3 days once and W2 = 5 days once) were tracked using the completely randomized design (RAL) with control treatment as comparison and 3 times replication. Data was analyzed using two-way ANOVA. The plant height, number of leaves, fresh weight, and calcium levels are the variables that were observed. The study revealed that P2W2 treatment had the highest development rate, with average number of leaves of 14 strands, growth height of 13.3 cm, fresh weight of 51.5 g, and calcium levels of 0.141%. Based on the results of the research, it was shown that coconut husks and eggshell liquid organic fertilizer are effective on the growth and increase calcium levels of kale.

1. INTRODUCTION

The completion of balanced nutritional suitability numbers will guarantee the well-being and health of Indonesians. Good sources of nutrition come from vegetables, meat, and fruits. Vegetables become one of the most important components of meeting nutritional needs because many contain the proteins and minerals that the body needs. One of the most important nutrients in vegetables is calcium. Calcium is very necessary for the period of human growth; the older a person is, the more calcium the body needs. When the need for this calcium is insufficient, it will cause inhibition of the human growth process or calcium deficiency, which will imply a high body growth disorder or stunting (Wibowo and Dasuki 2020). It is a serious problem that affects the health of the population and the fulfillment of intellectual and economic potential, such as malnutrition status, which can affect the health, growth, and development of children (Vaivada et al. 2020).

In order to prevent calcium deficiency, it is necessary to consume foods that contain calcium, such as milk, fruits, and vegetables. One of the vegetables high in calcium content (Ca) is kale plants. Based on the decision of the Minister of Agriculture No. 511/Kpts/PD.310/9/2006, kale plants are of the type of cabbage, which includes construction commodities. However, from the data obtained by the (Irjayanti et al. 2021) on the production of cabbage plants in Central Java from 2019 to 2021, there was a decline from 277,478 tons in 2019 to 245.502 tons in 2020 and a decrease in yield in 2021, which is 226.695 tons.

Some factors affecting the decrease in such output can be caused by a lack of plant nutrition from fertilization processes and inappropriate planting techniques. So efforts can be made to increase the output of this Kale variety cabbage plant by paying attention to soil nutrition and good planting techniques. Soil nutrition can be met with the use of fertilizers derived from organic materials. One is from the organic waste of coconut husks and egg shell; both are non-used parts, so they become waste only when they are not recycled or reused properly. Coconut husks and egg shell can be used as materials for the manufacture of liquid organic fertilizer, as they both have the macro- and micro-nutrients that plants need.

Coconut husks have quite good benefits because it contain the necessary compound elements for plants. In addition to having a natural source of potassium (K), coconut husk has the content of other benefits for plants such as phosphorus (P), calcium (Ca), magnesium (Mg), sodium, and some others (Harahap 2021). The concentration of liquid organic fertilizer in coconut husks has a real influence on the fresh weight of the potato kleci plant. The fresh weight is a representation of the collection of photosynthesis and water content in plants (Suripto et al. 2018). And on the egg shell, as much as 97% of calcium is contained in chicken egg shells. This high calcium levels is known as an excellent calcium carbonate compound as a raw material for making POCs and can raise the pH of soil and water media (Suhastyo and Raditya 2021).

Giving fertilizer to plants in a dose that corresponds to their needs is important because each plant has a different need for a different element. Too much or too little fertilizer will cause a decrease in the output of the plant itself. According to (Khotimah et al. 2020) Treatment P4 (300 ml of liquid organic fertilizer) may have administered an unbalanced or excessive dose of fertilizer to the plant, resulting in a significant decrease in the growth of collard saws. So the dose of fertilizer given must be appropriate so that the production of plants can be maximized. According to (Eka et al. 2018) from the treatment of liquid organic fertilizer by dividing the dose and time intervals showed results on average that the grain plant with the highest levels of calcium was found in the treatment P3W1 (liquid organic fertilizer with a dose of 13 ml and a time interval of 5 days) with a calcium level of 2.54 mg/g. The dose of 13 ml of liquid fertilizer gave tangible results on the collard plant, as seen from the test results of the increased calcium levels. The organic elements in liquid organic fertilizer will help soil absorb water and sunlight, making it more fertile. The aim of this study was to find out the effectiveness of the administration of liquid organic fertilizer from coconut husk and egg shells on the growth and increased calcium levels of kale plants (*Brassica oleracea var. achepala*).

2. MATERIALS AND METHODS

2.1. Place and Time

The research was conducted at the Green house of Biology Education, Faculty of Teacher Training and Education, University Of Muhammadiyah Surakarta, on the Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Central Java, Indonesia. And at the BPSMB Surakarta. The research starts from January – April 2023

2.2. Material and Tools

The required materials are divided into two categories, Materials for liquid organic fertilizer production with various formulations (organic waste of Coconut husk, egg shells, water, granulated sugar, and EM4 as starter liquid organic fertilizer) and materials during planting in the field (two-week-old Kale seedlings, polybags, and liquid organic fertilizer according to treatment,

ruler, soil media, etc.) and in the greenhouse (shovel, bucket, sprayer, camera, etc.) are required. In addition, material for calcium testing (Spectrophotometers).

2.3. Experimental Design

This study used a completely randomized design (RAL) with 2 factors, namely the dose of liquid organic fertilizer and the time interval for applying fertilizer, with 3 replications. The factors are as follows:

Factor 1: Dosage of Liquid organic fertilizer coconut husk and egg shell
P1 = 100 ml of liquid organic fertilizer
P2 = 150 ml of liquid organic fertilizer
Factor 2: Time interval for the application of liquid organic fertilizer
W1 = 3 days once
W2 = 5 days once

2.3.1. Treatment plan

P / W	W_1	W_2
P_1	P_1W_1	P_1W_2
P_2	P_2W_1	P_2W_2

Treatment control P0W0 as compare for treatment plant

Description:
P0W0 (Control) = Only Water every days
P1W1 = 100 ml of liquid organic fertilizer + Once every 3 days
P2W1 = 150 ml of liquid organic fertilizer + Once every 3 days
P1W2 = 100 ml of liquid organic fertilizer + Once every 5 days
P2W2 = 150 ml of liquid organic fertilizer + Once every 5 days
From the treatment repeated 3 times repeatation, so it takes 15 (5 x 3) experimental plots.

2.4. Research implementation

2.4.1. Production of Coconut Husk and Egg Shell Liquid Organic Fertilizer

After getting all of the components and implements ready, the next step was to clean and cut up some of the organic waste products, such as coconut husk and egg shell., combined with 50 liters of well water, brown sugar, and EM4 solution, placed in a sealed container, stirred until smooth, and fermented for two weeks. The liquid organic fertilizer is filtered and placed in ready-to-use jerry cans before being applied to the land in accordance with the prescribed treatment.

2.4.2. Planting and Maintenance of Kale Plants

a) Planting and fertilization: Following the completion of the soil's preparation, the planting of the kale seedlings in the polybags can begin. Following the planting, the procedure is continued by the application of a liquid organic fertilizer made from

coconut husk and eggshell in accordance with the treatment. This application occurs once every three days and once every five days.

b) Kale plant maintenance: From planting to harvest, plants are watered once per day in the morning or evening during the arid season. The subsequent step is the mechanical removal of weeds. At the time of weeding, the insect is eliminated if an infestation is present. Virus-free seeds, proper sanitation, crop rotation, uprooting, tossing, or burning damaged plants in a distant site, removing and destroying eggs or caterpillars that attack plants, and other natural methods are used to control pests and illnesses. Other natural approaches include: crop rotation.

2.4.3. Calcium Test

Based on (Badan Standardisasi Nasional 1992) Calcium testing procedure by method CPC (O-Cresolphthalein-Complexone). Weigh 1 g of kale plants and put them in a porcelain or 100-ml Pyrex glass cup. Use a pipette to add 10 ml of a magnesium nitrate in ethanol solution blended with a mixer bar. Evaporate ethanol over the water taper, mix it once, heat it over the electric taper, and close the glass cup with the watch glass. Move the glass cup into a barrel at 2000 °C, gradually elevate it to 5000 °C for 2 hours, and blur all night at 450 – 5000 °C. Leave the glass on the asbestos. After cooling, add 1 ml of water and 2 ml of HNO3 p.a. and dry over the water bath if carbon residues remain. Reheat for 1 hour at 5000 °C. Repeat until white ashes appear. Add 5 ml of the HCl/HNO_3 solution to the ashes through the glass cup wall and heat over the water bath until the ashes dissolve. Impregnate a 100-ml volumetric flask with boiling water after quantitatively transferring the solution. Filter-paper: Whatman-540. Cooperating with Blanco. A spectrophotometer measures standard solutions, blank solution, and kale absorption. Create an absorption-concentration calibration curve. The calcium found in kale plants is calculated using the formula:

$$Calcium\ levels = \frac{C \times P \times V}{W}$$

Where: *Calcium levels* is calcium content (%), *C* is initial of ug metal/ml from the calibration curve, *P* is initial of dilution, *V* is initial volume of solvent (ml), and *W* is weight of kale sample (g).

2.5. Data Calculation and Analysis

The data obtained in the study will be analyzed using two-way ANOVA on a complete random design. (RAL). SPSS 20.0 is a computer program used for statistical analysis. It is used to analyze whether there is an interaction between fertilization factors using liquid organic fertilizer from coconut seals and egg shells with different fertilizer levels and nutrition delivery times.

3. RESULT AND DISCUSSION

Based on the research that has been carried out, the data obtained from the observation results of the sensory growth test of kale plants on the soil medium of polybag for 1 month with different fertilizer concentrations and time intervals have different results. The measurement parameters

used are plant height, number of leaves, wet weight, and calcium content. Observation data was obtained as follows:

Table 1. Average Data of Plant Growth

Treatment	Number of Leaves (Strands)	Plant Height (cm)	Plant Weight (g)	Calsium (Ca) Levels (%)
P0W0 (Control)	5,33**	4,67**	31,40**	0,076**
P1W1	8,67	8,67	37,70	0.123
P1W2	10,33	6,50	38,43	0.136
P2W1	12,33	11,33	44,50	0,139
P2W2	14,33*	13,33*	51,53*	0,141*

Description :
* Plant growth with the highest average value
** Plant growth with the lowest average value

3.1. Number of Leaves

Based on Table 2 that shows the results of the hypothesis test of the number of leaves using the ANOVA Two-Way technique. The value of significance of the influence of fertilizer concentration and the time interval of fertilizer administration on the amount of leaves is 0.701 compared with the level of significance of 0.05, so that the value sig 0.702>0.05.

Table 2. The hypothesis test of the number of leaves Tests of Between-Subjects Effects Dependent Variable: Response Y Number of Leaves

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Model	1703.667[a]	5	340.733	638.875	.000
Doses_P	44.083	1	44.083	82.656	.000
Time_W	10.083	1	10.083	18.906	.001
Doses_P * Time_W	.083	1	.083	.156	.701
Error	5.333	10	.533		
Total	1709.000	15			

a. R Squared = .997 (Adjusted R Squared = .995)

It can be understood that the concentration of fertilizer and the time interval of fertilizer donation do not interact, so it does not affect the growth of the number of leaves on kale plants. This is consistent with the results of the study (Khasanah et al. 2018) which show that the slow-release urea fertilizer of the composite matrix does not affect the growth and yield of caisim plants at ages 14, 21, and 28 hst, This suggests that the number of leaves is unaffected by the application of urea fertilizer or delayed release because the plant's roots have not yet absorbed the available nitrogen. One of the factors most likely to cause low leaf production output is uncontrollable environmental factors, such as long sun exposure and temperature at the research site. According to research results from (Cahyono 2016) N, Fe, and Mg are the most important constituents in the increase in leaf count. When cell division occurs at the end of the stem and the plant obtains

carbohydrates through photosynthesis, the number of leaf filaments can increase. The results of observing the average increase in the height of the kale that were treated with fertilizers and different watering intervals can be seen in the graph below:

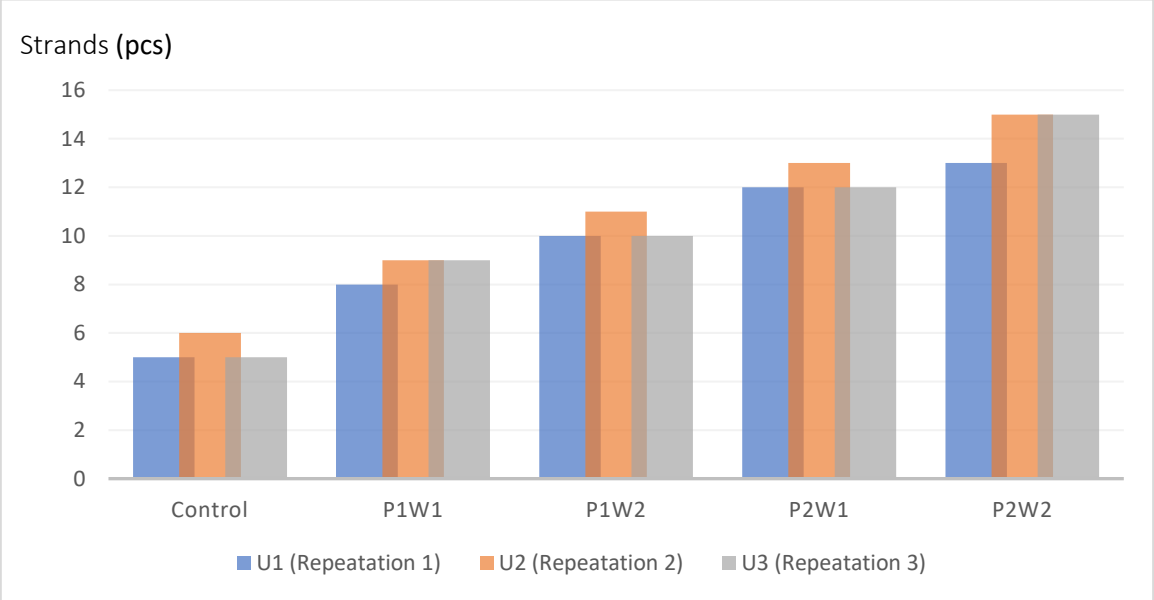

Fig. 1. The Number of Leaves

It can be understood that the higher the dose of fertilizer and the ideal time for fertilization can makes greater the number of kale leaves, On the measurement parameter of the number of leaves, the highest ratio value on the P2W2 behavior (Liquid organic fertilizer concentration of 150 ml with administration time of every 5 days) is 14 strands. While the ratio of the lowest number of leaves is on the control treatment, or P0W0 (without fertilizer concentration), which is only 4 strands. This is because the supply of liquid organic fertilizers from the combination of coconut husk and egg shell has not good enough to influence on the number of leaves of kale plants because the fertilizer contains low nitrogen which is one of the essential element of hares. According to the results of the study (Pramitasari et al. 2016) which stated that the dose of nitrogen fertilizer affected the leaf area and the number of leaves produced, it was shown that a treatment of 126.5 kilograms of nitrogen per ha-1 (N5) produced a larger leaf surface area than a treatment of 92 kilograms of nitrogen per ha-1 (N2). Thus, if the plant receives a sufficiently high amount of nitrogen fertilizer, the number of leaves produced will increase, resulting in a larger leaf area.

3.2. Plant Height

Plant height growth is one of the parameters that can be measured to determine the growth of mustard greens. Based on the results of Figure 2 shows the process of sensory testing the growth of kale plants on the high parameters of the kale using ruler, A high ratio of kale plant trunks treated with fertilizer doses and different time intervals shows the average high increase of the different kale plant stems.

Fig. 2. Measurement of Plant Height

Based on the results of In Table.2, the results of the test of the number of leaves using the ANOVA Two-Way technique indicate that the significance of the interaction of the influence of fertilizer concentration and the time interval of fertilizer administration on the height of the stem is 0.002 compared to the significance level of 0.05, so the sig value is 0.002<0.05.

Table 3. The hypothesis test of Plant Height Tests of Between-Subjects Effects Dependent Variable: Response Y Plant Height of Kale

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Model	1336.083[a]	5	267.217	372.860	.000
Doses_P	67.688	1	67.688	94.448	.000
Time_W	.021	1	.021	.029	.868
Doses_P * Time_W	13.021	1	13.021	18.169	.002
Error	7.167	10	.717		
Total	1343.250	15			

a. R Squared = .995 (Adjusted R Squared = .992)

The interaction between the factor providing fertilizer concentration and the time interval provides fertilizer has a significant effect on the stem height of kale plants. This is consistent with the research findings (Harjo 2021) that the use of various concentrations of liquid organic fertilizer on carrot plants has a noticeable effect on plant growth, with the highest dose of 0.75 liters of liquid organic fertilizer per 15 liters of water. The P2W2 treatment (liquid organic fertilizer dose of 150 ml and POC administration time of 5 days once) showed the best results, with an average high increase of 13.33 cm. Whereas the highest increase of plants is the lowest at the Control P0W0 treatment (only irrigated with water), the average value of the high increase is only 4.66 cm. This is due to the fact that P0W0 does not use fertilizer, so the growth of plants becomes slow. This can occur due to a lack of the necessary potassium-based element, so that photosynthesis produces fewer nutrients than plants with higher plant-based elements. (Anzila dan Asngad 2022) stated in the results of their research that the element potassium is very important for the growth of salmon crops. Potassium triggers high levels in Pak Choy plants and acts as an enzyme activator in metabolism. If potassium is lacking, the plant can become dwarfed. According to (Advinda 2018) the provision of hares in the vegetative phase with sufficient concentration can provide

optimal results for plant growth. In Figure 3, it can be seen that the graph of improvement on each treatment in its repeat has a different high increase of the rod.

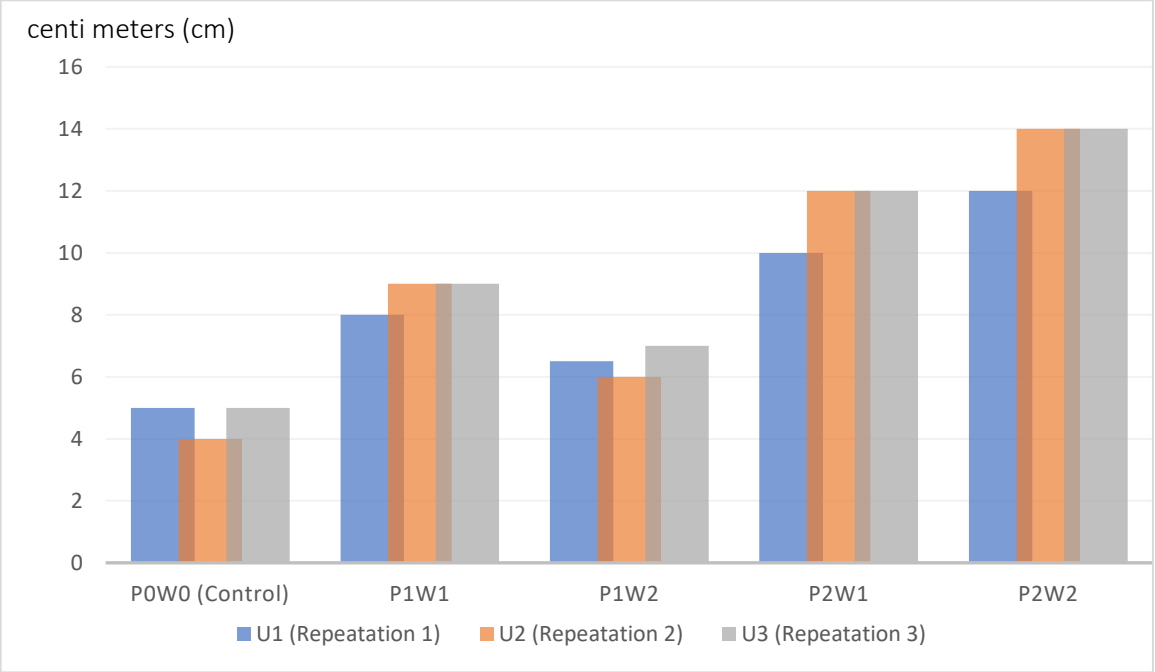

Fig. 3. Plant Height

It means that the best repeat results are on U3 in the treatment P2W2 and the lowest on U2 control. The high stems of kale plants with treatment P3W2 have the highest growth of the stem due to the nutrition obtained from the liquid fertilizer combination of coconut husk and egg shell as well as the ideal fertilization time. This indicates that the nutrient elements available in the soil meet the needs of plants to increase the height of the stems. Fertilizers containing the elements N, P, and K can maximize the growth of plants. Coconut sable contains other elements that are beneficial to plants, such as phosphorus (P), calcium (Ca), magnesium (Mg), Sodium (Na), and some others nutrient (Harahap 2021).

3.3. Plant Weight

Plant fresh weight is one of the parameters that can be measured to determine the growth of plants. The measurement of the wet weight of the plant is done at the end of the observation in the fourth week, that is, at the time of harvest. The results of the test of the number of leaves hypothesis using the ANOVA two-way technique are presented in Table. 4 These results are as follows: it is possible to determine that the value of significance of the influence of the concentration of fertilizer and the interval of time of fertilization on the height of the stem is 0.000 in comparison to the level of significance of 0.05, which means that the value sig is 0.000<0.05.

Table 4. The hypothesis test of Wet Weight Tests of Between-Subjects Effects Dependent Variable: Response Y Fresh Weight

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	25560.917[a]	5	5112.183	15065.373	.000
Doses_P	297.007	1	297.007	875.268	.000
Time_W	45.241	1	45.241	133.323	.000
Doses_P * Time_W	29.767	1	29.767	87.723	.000
Error	3.393	10	.339		
Total	25564.310	15			

a. R Squared = 1.000 (Adjusted R Squared = 1.000)

It can be understood that there is an interaction between the administration of fertilizer doses and the time interval between fertilizer doses that has a real effect on the fresh weight of kale plants. The high K content in coconut husk liquid organic fertilizer can increase the plant's fresh weight by increasing the number of cells and decreasing transpiration. The difference in the resulting wet weight of kale plants can be seen in Figure 4, where the fresh weight of kale plants weighed using a digital balance shows a tangible difference in results.

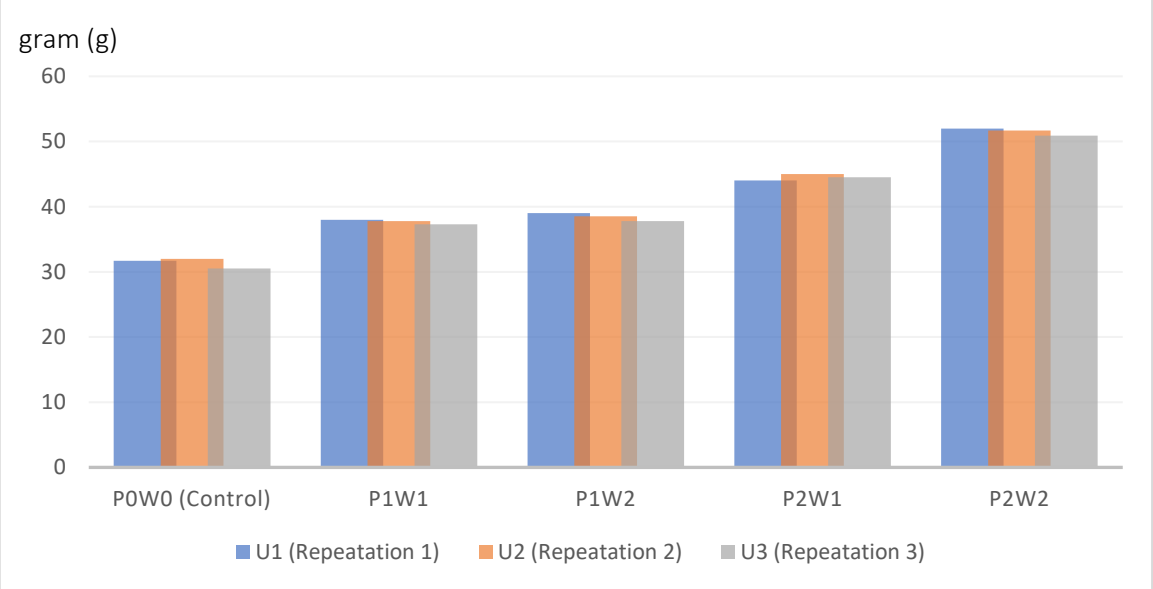

Fig. 5. Plant Weight

Based on Figure 5, it can be concluded that the U1, U2, and U3 graphs for each treatment in 3x repetitions almost form a parallel line, indicating that the average moist weight of plants treated with liquid organic fertilizer from coconut husk and eggshell has a stable defect value. This is due to the interaction between the fertilizer dose factor and the time interval of irrigation, which has a real effect on the fresh weight of kale. In this study, the data obtained the average value of the highest plant wet weight on the treatment of P2W2, with the average wet weight of the plant being 50.9 grams. Whereas the fresh weight value is the lowest on the P0W0 control treatment with an average fresh plant weight of 30.5 grams. Based on the average net weight column of kale plants in Table 1, treatment P2W2 produced the highest weight of kale plants after storage of 51.53 g,

while the lowest wet weight was produced from the control treatment of 31.4 g. This is due to the essential factor of fertilizer that increases the weight of plants, one of which is the calcium content in coconut husk and egg shell fertilizer, which has several functions to maintain the stability of cell walls and can increase the fresh weight of the plants. According to (Thor 2019) Calcium is an important factor for cell walls and membrane stability. When Ca supply is low or Ca transport is disrupted, local calcium deficiency occurs, which can lead to membrane damage or cell wall strengthening failure (Hocking et al. 2016).

3.4. Percentage of Calcium Levels

Calcium is especially needed for the human growth period from the time of infants and children to adults. The older a person is, the more calcium the body needs. Each person's calcium needs range between 400 and 1000 mg/day (Qurniani 2017). Calcium plays an important role in the formation of plant cell walls in humans, as well as the formation of bones, teeth, and other body structures (Noviyanti et al. 2017). Calcium levels testing in kale plants is carried out at the end of the observation after harvest, which is at week 4. In this study, the calcium content of kale plants was tested at BPSMB. The calcium testing was performed with a spectrophotometer with a wavelength of 422,7 n/m based on (Badan Standardisasi Nasional 1992).

In **Table.5** the results of the calcium level hypothesis test using the ANOVA Two-Way technique show that the significance value of the influence of fertilizer concentration and the time interval of fertilizer administration on calcium levels is 0.001, compared with the level of significance of 0.05, so that the value of sig 0.001<0.05.

Tabel.5 The hypothesis test of Calcium Levels Dependent Variable: Response Y Calcium Levels

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Model	.243[a]	5	.049	19200.684	.000
Doses_P	.000	1	.000	126.447	.000
Time_W	.000	1	.000	52.632	.000
Doses_P * Time_W	5.633E-005	1	5.633E-005	22.237	.001
Error	2.533E-005	10	2.533E-006		
Total	.243	15			

a. R Squared = 1.000 (Adjusted R Squared = 1.000)

It can be understood that there is an interaction between the doses of fertilizer doses and the time interval of fertilizer administration that has a real impact on the growth of kale plants. This is in line with research of (Eka et al. 2018) The calcium content of selada plants given liquid fertilizers from gerampadi waste and chicken egg shells has a calcium content on treatment P3W1 (fertilizer of 13 ml with a 5-day fertilizer time interval) of 2,54 mg/100 g. Giving kale plants organic fertilizer liquid made of coconut husk and eggshell can thereby increase the amount of calcium that the plants contain. In addition, the calcium content (Ca) in liquid organic fertilizers made from coconut husk and eggshell can help to reinforce the plant stems, stimulate the growth of new roots, and assist the overall development of plants. Result of each treatment shown in Figure 6 that calcium levels in kale plants at each repeatation U1, U2, and U3 increased, which

can be interpreted to mean that the higher the dose of fertilizer given and the ideal fertilization time, the higher the levels of calcium in kale.

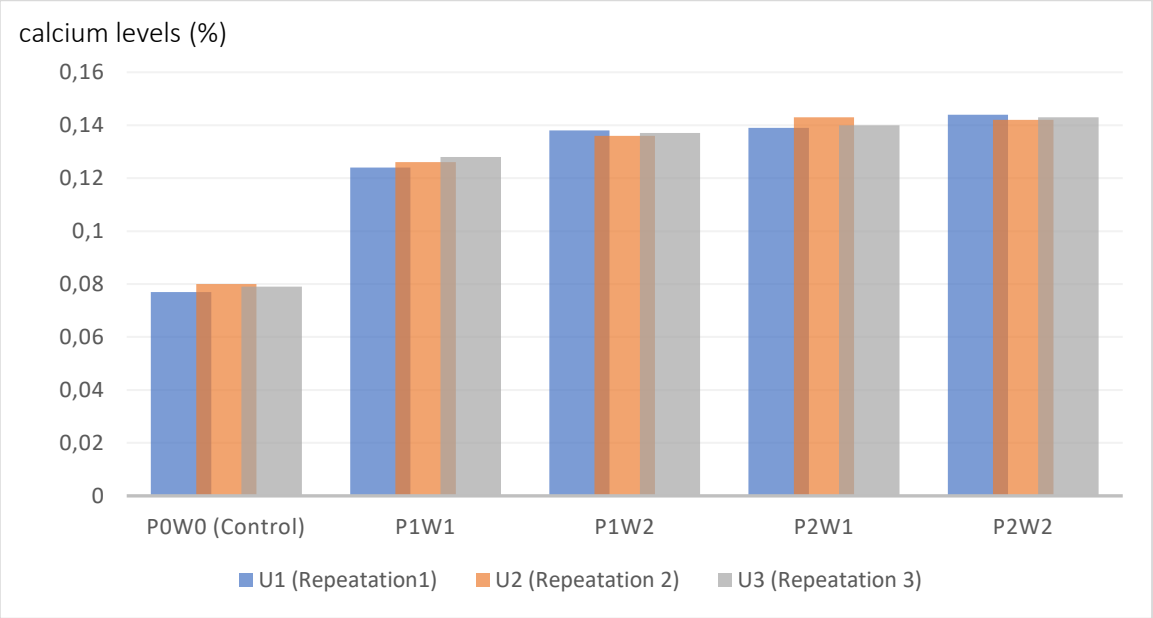

Fig. 6. Calcium (Ca) Levels

The ratio of calcium levels with the best results on treatment P2W2, which has a calcium level on 1 gram of kale of 0.141 % and the lowest calcium content on treatment P0W0 (control), which is on 1 gram of kale, is only 0.076 %. From the data, it can be understood that organic fertilizer, liquid coconut husk, and egg shells influence the increase in calcium levels. This is due to the presence of calcium content in coconut husk and egg shells. The dissolving Ca in the soil makes it easier for plants to absorb the elements, so it can affect the calcium contents found in kale plants. Coconut husk contains 53.83% macro and micro water, 0.28% sodium, 0.1% phosphorus, 6.726 ppm potassium, 140 ppm calcium, and 170 ppm magnesium, so coconut husk can be used as a material to make liquid organic fertilizer (Ramadhan et al. 2018). Chicken egg shells contain 97% calcium, which makes them an excellent calcium carbonate compound for making POCs and increasing the pH of soil and water media (Suhastyo dan Raditya 2021).

4. CONCLUSION

On the variables of plant height, leaf number, fresh weight per plant, and calcium content, there is a very substantial effect. On kale crop land, The most optimal combination of liquid organic fertilizer made from coconut husk and eggshell that produces the greatest growth and yields is a treatment of P2W2 with an average number of leaves of 14 strands, a growth height of 13.3 cm, a fresh weight of 51.5 g, and calcium levels of 0.141 %.The suggestion of the researchers is to carry out advanced research with the use of higher concentrations of fertilizer, conduct advanced studies with different irrigation time intervals, and conduct an advanced study of testing the contents of calcium levels on plant in liquid organic fertilizers combined with coconut husk and eggshells. Based on the aforementioned findings, it is prudent to conduct additional research on the how, when, and dosage of liquid organic fertilizer in various climatic conditions, locations, and commodities. Utilizing liquid organic fertilizer made from coconut husk and eggshell is recommended when preparing kale plant cultivation land and its environs.

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