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The Effect of Homemade Fertiliser on *Mesona chinensis* (Grass Jelly)

Nurain Amiera Abu Samah[1], Muhammad Firdaus Abdul Karim[1,2*], Noor Janatun Naim Jemali[1,2], Marinah Muhammad[1],

[1]Faculty of Earth Science, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia
[2]UMK-Tropical Rainforest Research Centre (UMK-TRaCe), Faculty of Earth Science, Pulau Banding, Gerik 33300, Perak, Malaysia
*Correspondence: firdaus.ak@umk.edu.my at Faculty of Earth Science, Universiti Malaysia Kelantan

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Abstract: Fertiliser aids to enhance plant growth and productivity due to inadequate nutrient supply from the soil. Nowadays, the agriculture sector faces some difficulties due to limited land availability that affect the global food demand. The difficulties can be overcome by using chemical fertiliser where it can increase the crop yield in a short period. However, excessive usage of chemical fertilizers can lead to several environmental issues such as soil pollution and deterioration. To promote sustainable agriculture practices, a study of the effect of homemade fertiliser on *Mesona chinensis's* plant growth was conducted. Two types of organic fertilizer from onion husk and coffee residue were applied to *M. chinensis*. Planted and soil parameters were measured. Both fertilisers showed increases in plant height and the number of leaves. Hence, the fertilisers also influence in controlling soil moisture due to the improvement of soil retention.

1. INTRODUCTION

Mesona chinensis is an herbal plant that is commonly used as a medicine and dessert in Southern Asia. The scientific name of *M. chinensis* is Platostoma palustre. M. chinensis belongs to Lamiaceae (mint), an angiosperm that is listed as the sixth-largest family. The local name is known as 'Black cincau' or 'cincau hitam' in Malaysia which is an edible jelly. *M. chinensis* has a lot of benefits to human health and consists of a bioactive metabolite that promotes antidiabetic, anticancer, and antihypertensive properties (Sasmita & Ling, 2017).

Consequently, the agriculture sector faces daunting and complex challenges to meet the global food demand with limited land availability. Thus, the farmers will use conventional ways to increase their crop yield by using chemical fertiliser in the agriculture sector. However, the excessive use of chemical fertiliser can lead to environmental problems such as greenhouse gas emissions that consist of carbon dioxide, methane and nitrous oxide that are usually emitted by nitrogen-based fertilisers (Wood & Coiwe, 2004). Besides, plant health and fertility declining in the long term due to excessive usage of chemical fertiliser. One of the sustainable practices was used as an alternative using chemical fertiliser by using organic fertilisers derived from various sources including food waste.

Onion husk and coffee residue are examples of common organic waste used as fertiliser because of accessibility and a cheaper option. Alternatively, the application of organic amendments derived from food waste such as coffee residue and onion husk offered the potential to minimize the negative impact on soil and plant health. The has many studies that cover in many perspectives such as the recommended application rate of fresh and composted coffee residue and the tolerance of inhibitory effect of certain types of plants. However, there are insufficient data or studies on the potential of onion husk and coffee residue as organic soil amendments for *M. chinensis*. In addition, the study of *M. chinensis* in the agriculture and soil conservation context is still insufficient. Further research is needed to contribute information about the effect of organic fertiliser applied as organic composts on the soil. According to Unnisa (2015), uncontrollable food waste products can lead to greenhouse gasses that release methane and carbon dioxide. The objectives of this study are as follows: (a) To determine the growth and survival rate of *M. chinensis* saplings in sandy clay soil growth medium. (b) To study the effect of homemade fertiliser on plant growth.

2. MATERIALS AND METHODS

2.1. Study area

The sampling site was conducted in Taman Sri Rembau Fasa 2, a residential area in Rembau. Rembau district consists of 402.76 square km and 41,512 hectares with a population of 43,011 people. Rembau consists of three types of landforms including mountain, hill and flat plain. The region surrounding the sampling site has a warm and humid climate every year. The sampling location (2° 35'N, 102° 06'W) is a small plot (4.57 m × 2.74 m) that was set up to conduct the effect of homemade organic fertiliser on *M. chinensis*. All the plants will be placed in an open area without using greenhouse shelves. The soil types of the site are nitosols and alluvium (Salim, Norbani, & Rahman, 2014). The sampling site is located around the hill forest and the main vegetation is *Shorea acurtisii*.

2.2. Preparation of *M. chinensis*

The *M. chinensis* is cultivated from the parents using propagation techniques. This technique consists of two types which are asexual and sexual propagation. In this study, the stem cutting technique is used to create new *M. chinensis* saplings. The stem of *M. chinensis* will be cut about 5 -10 cm below the tip using a pruner to give a clean cut. The leaves on the stem will be removed 1 inch from the bottom.

2.3. Preparation of homemade fertilizer

Homemade fertiliser consists of coffee residue and onion husk collected from home. Firstly, the coffee residue dried after collection where it was applied as solid fertiliser. Then, onion husk is used as liquid fertiliser. The onion husk was weighed into 10 g and soaked into 130ml of water with a ratio 1:15. The onion husk was soaked for 24 hours in the closed container. After 24 hours, the liquid was filtered using a sieve to sort out the husk before applying it to the soil. The onion husk needs prepared fresh to avoid any growth of microbes that could infect the plant.

2.4. Experimental design

2.4.1. Growth and survivability of *M. chinensis* in sandy clay soil growth medium

A total of 24 new saplings of *M. chinensis* as described in section 2.2 are transplanted into the growth medium. The growth medium is a thorough mixture of clay and sand with ration 2:1, weighed to 1.2kg and transferred into polybags. Then, the 24 new saplings of *M. chinensis* were transplanted upright in the medium. Then, the stem was stuck upright in the medium to 1 inch. The transplanted sapling units are placed under half-sun sun exposure following a random block design that comprises 4 groups × 6 replications = 24 units. The four groups are labeled as A, B, C and D, respectively to account for the blocking effect. The plant growth which is height, number of leaves, leaf area and soil parameters which is pH, temperature, moisture are measured for a total of 14 days after transplanting to test for growth and survivability of *M. chinensis*. The data generated from this experiment is employed to establish an improved experimental design to test for the effect of homemade fertiliser on the growth of *M. chinensis*.

2.4.2. The effect of homemade fertiliser application on the growth of *M. chinensis*.

A total of 24 new *M. chinensis* saplings are propagated using the stem cutting technique as described in section 2.2. Next, the 24 new saplings are transplanted into an improved growth medium and referred to as experimental units. The growth medium consists of two types of soil which are clay and sand. The total of the medium is 1.2kg that consisting of 1.1 kg of clay and 100 g of sand with a ratio of 1:11 with clay that was inserted first into polybags and followed by the soil on the top. The experimental units are assigned to a randomized block design consisting of 4 treatment groups × 6 replications = 24 units. The four treatment groups are onion husk water (100 ml), coffee residue (10 g), coffee residue + onion husk water (1:10) and control (no application of homemade fertiliser). The homemade fertilisers are applied evenly on the 600 cm² soil surface at day 7 after the day of the transplant. All experimental units are watered daily throughout the experiment period.

2.5. Plant growth measurement

2.5.1. Plant Height and Number of Leaves

The height of the plant was measured 2 cm from the soil to the tip using measuring tape because the soil condensed resulting from watering. The measurement was taken after straightening the plant to the fullest length and measurement was done using a measuring tape. Then, the number of healthy leaves will be calculated. The bias was avoided by calculating all leaves that are visible including the new leaf tips.

2.5.2. Leaf area

A picture of any random *M. chinensis* leaf was taken against a white background for all experimental units. Those pictures are uploaded on ImageJ (NIH, USA) and analyzed using a scale that was set earlier which is in cm². Then, the picture was converted to 8-bit that transformed into grayscale. Then, an automated threshold that includes the dark green area of the image and measures the leaf area.

2.6. Soil measurement

2.6.1. Soil temperature

The measurement for soil temperature was taken in Celsius (°C) using a temperature probe (Microtempelectrics, Taiwan). The depth for soil temperature measurement of each of the individual plants is 10 cm where the probe will be placed into the soil gently before taking the measurement.

2.6.2. Soil ph

Soil pH measurement was taken using a pH probe (Microtempelectrics, Taiwan). The probe was placed gently into the soil straight and vertically about half of the polybag. The probe was placed away from the stem to minimize damages to plant roots when taking the measurement was taken after watering to ensure that the value is readable. The value that was displayed in the probe is in the number that was referred to the reference list that was provided by the equipment.

2.6.3. Soil moisture

The soil moisture was taken using the same probe as described in 2.6.1. The probe (Microtempelectrics, Taiwan) was placed gently into the soil straight and vertically about half of the polybag. The measurement was taken after watering to ensure that the value is detected by the probe. The reading that was displayed in the probe consists of five levels which are very dry (dry+), dry (dry), normal (nor), wet (wet) and very wet (wet+).

2.7. Light intensity

The light intensity was taken using the probe (Microtempelectrics, Taiwan) for seven days. The reading was recorded according to the categorical variables that consist of nine levels which are very low (low-), much low (low), little low (low+), few low (nor), normal (nor), few high (nor+), little high (hgh-), much high (hgh) and very high (hgh+).

2.8. Statistical analysis

All the data were analysed using descriptive statistics due to non-normal data using Minitab (Minitab 17 Statistical Software, USA). Descriptive statistics helps to summarize all the data in the research. The mean, standard error (S.E.) of mean, Standard deviation (S.D.), minimum, median, maximum and range were calculated and only median was used in this study for all the parameters. A Kruskal-Wallis test (Minitab 17 Statistical Software, USA) was conducted to test the parameters which are plant growth and soil that was influenced by the fertiliser in the 10 days.

3. RESULTS

3.1 The Growth and Survivability of *M. chinensis* Sapling

The experiment to test for the growth and survivability of propagated *M. chinensis* saplings are done within two weeks. The 24 units plants were transferred into a sandy clay soil medium. The measurement of the parameters was done for six days. The plants were watered daily with 150 ml of watering water. Overall, the survivability rate for the newly transplanted *M. chinensis* saplings is 54%. The plant saplings started to wilt on day 2 after transplanting into the growth medium. Based on general observations, dead plant saplings either have no root or little root. This causes the plant to not receive the water and nutrients from the soil. The plant was classified as dead when the appearance started to turn brown and dry including stem and leaves.

Figure 3.1(a) shows how the plant died within 2 weeks. From that figure, the plant started with positive growth on day 0 until day 3. After day three, it started to show negative growth where it shows that the lines started to decline. The line keeps declining until day 14. From that figure, the group with the highest plant survivability is group A followed by group D, while group B and group C show similar trends. Then, Figure 3.1 (b) shows the percentage of plants that are alive within 2 weeks. From that figure, all the group was started with 100% where all 24 plants were alive on day 0. However, the percentage decreased when it reached day 14. Plants in group A reached 50% of survivability with 6 plants alive while group D reached 42% of survivability with five plants survived. Then, group B and C reached the same percentage of survivability which is 25% with only three plants surviving.

Table 3.1 The value of plant and soil parameters in the survivability test on *M. chinensis.*

Parameters	Group			
	A	B	C	D
a) Plant Growth				
i. Height (cm)	5.60	5.60	5.60	5.60
ii. No. of leaves	2	2	2	2
iii. Leaf area (cm^2)	879.8	717.2	146.7	1154
b) Soil				
i. pH	5.75	5.30	5.15	4.70
ii. Temperature (°C)	30.00	30.00	29.00	30.00
iii. Moisture level*	3.00	5.00	5.00	5.00
iv. Light Intensity level*	1.00	1.00	1.00	1.00

* It was recorded according to the categorical variables.

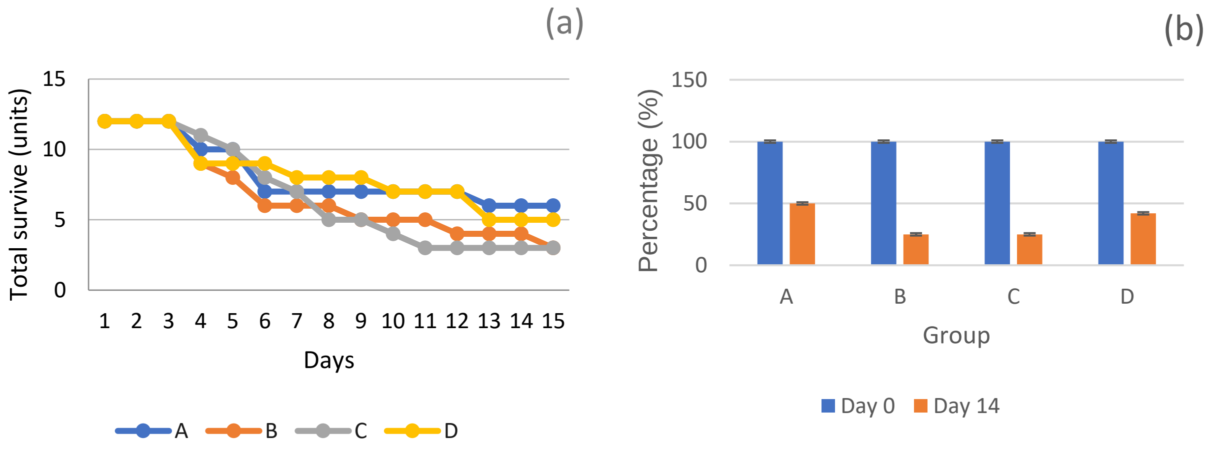


Figure 3. 1 a) the survivability and b) percentage of *M. chinensis* after 14 days of preliminary testing

3.2Effect of Homemade Fertiliser on The Growth of *M. chinensis*

After conducting the survivability of the *M. chinensis* the experiment to test the effect of homemade fertiliser on its growth was conducted the experiment to test the effect of homemade fertiliser on its growth was conducted within 10 days after transplanting into an improved growth medium. The parameters were measured from day 0 until day 10. On day 7, four treatments was applied to all plant which are control, coffee residue, onion husk and mixed of onion husk and coffee residue. From day 7 to day 10, all the plant was observed closely after receiving treatment. Based on the result, all the plants show positive growth.

Parameters for plant growth consist of the number of leaves, area of leaves and plant height. The overall result is presented in Table 3.1.

Table 3.2 The median value of plant growth and soil parameters.

Parameter	Treatment			
	Control	Coffee residue	Onion Husk	Coffee residue + Onion husk
Plant height (cm)	5.40	5.35	5.65	5.60
No. of leaves	2	2	2	2
Leaf area (cm^2)	13.64	13.59	10.34	13.59
Soil pH	4.85	4.50	4.60	5.10
Soil temperature (°C)	31.50	31.00	31.00	31.00
Soil moisture level*	4.00	4.00	5.00	5.00
Light intensity level*	1.00	1.00	1.00	1.00

* It was recorded according to the categorical variables.

Table 3.2 (i) Kruskal-Wallis based on the parameter of the plant growth and soil.

Parameter	Median	H-value	P-value
Plant height (cm)	22	16.290	0.010
No. of leaves	8	4.780	0.188
Leaf area (cm^2)	51.6	17.240	0.010
Soil pH	19	13.71	0.003
Soil temperature (°C)	124.5	3.020	0.388
Soil moisture level*	18	6.980	0.073
Light intensity level*	4	0.000	1.000

Based on the Figure 3.2(a), there has a difference in plant height before and after treatment. The height of the plants increases after applying the treatment. The height of the plant in the control group did not show much difference because it does not receive any treatment. The heights of plants were increased with coffee residue. However, the plant when receiving onion husk and mixed fertiliser from coffee residue has huge differences compared to control and coffee residue. The height when receiving the onion husk and mixed fertiliser is increasing which makes it has a huge difference between control and coffee residue but not much difference compared to onion husk.

Figure 3.2(c), shows the number of leaves before and after receiving the history. The number of leaves increases after applying the fertiliser. For control, the number of leaves increases despite it does not receive any treatment. This difference may be due to another factor. For coffee residue, the number of leaves still increases although the differences are low after the treatment compared to another treatment.

The number of leaves increases drastically after receiving the onion husk as fertiliser. This makes the treatment of onion husk produce the number of leaves more than treatment control and coffee residue at second followed by the plants receiving mixed fertiliser (coffee residue + onion husk). The number of leaves after receiving mixed fertiliser increases drastically compared to control and coffee residue that shows a huge gap. However, the difference between onion husk and mixed fertiliser is low compared to other treatments. According to a study conducted by the Zainab et.al., (2016), the organic fertiliser that was used are cow dung and poultry litter shows positive results where the plant which is okra have the highest number of leaves other than another fertiliser.

Figure 3.2 (b) shows that the reading for leaf area increases until treatment coffee residue where after that it decreases when receiving mixed fertiliser. The difference for each treatment before and after receiving is small. The leaf area started to increase when receiving treatment but the leaf area of the onion husk decreased after receiving the fertiliser. The difference of each treatment before and after receiving is small compared to other parameters.

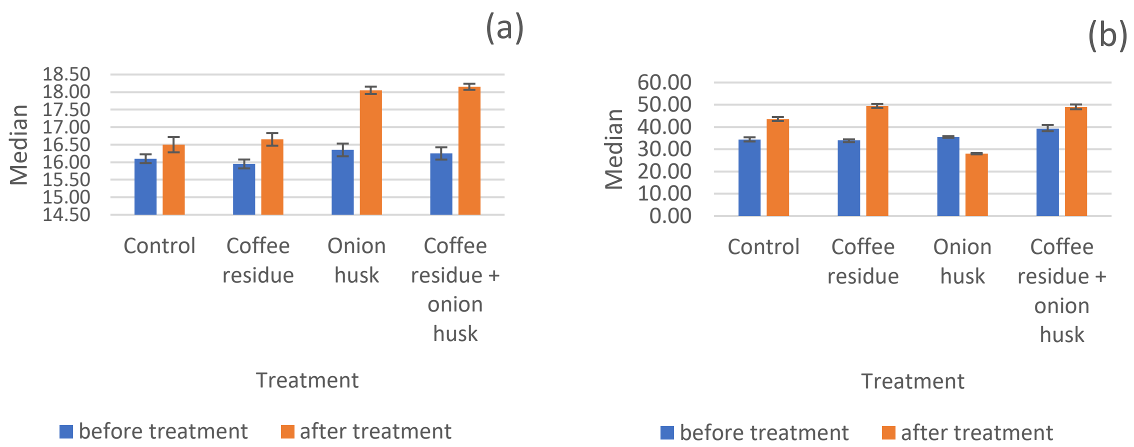
The changes in the soil pH, moisture and temperature were measured. Based on Figure 3.3(a), the overall result of pH reading before and after treatment was presented. The soil pH or all treatments increases after the treatment except for onion husk where it decreases slightly including the plant that receives treatment of mixed fertiliser. All the plants did not show much difference between the treatments compared to other parameters. The soil pH control group increased day by a day even though treatment was given. For soil that receives coffee residue as treatment, the pH started to increase after receiving the treatment. The soil pH that receiving onion husk as a treatment is slightly decreased. Among of four treatments, the soil pH that receiving mixed fertiliser started to decrease after receiving the treatment.

The trends of the soil temperature before receiving treatment started to decrease and remain the same from coffee residue and onion husk and the temperature increases at mixed temperature (Figure 3.3b). Soil temperature at control decreases after receiving the treatment while the temperature of soil after receiving coffee residue remains the same. But, with onion husk the temperature was observed drops. The soil of mixed fertiliser decreases after receiving the treatment. The moisture of the soil before receiving treatment shows not much different from each other except for mixed fertiliser (Figure 3.3c). The moisture of the soil increasing after the treatment with a huge difference. The soil moisture after receive treatment of mixed fertiliser is the highest and the lowest in control.

Overall, plant growth and changes in the soil gives some interesting result. For plant growth, the onion husk and mixed fertiliser of coffee residue and onion husk give different for the plant height where it started to increase after receiving the treatment. For the leaves area, coffee residue and mixed fertiliser contribute to the leaves area after the treatment while the number of leaves was contributed more by onion husk and mixed fertiliser. Out of all treatment, mixed fertiliser helps the growth of the plant more than other fertiliser and follow by onion husk that contributes to plant height and number of leaves.

For the changes in the soil, the moisture of the soil seen increasing after receiving treatment. There has a study conducted by Ye, Liu, & Niu (2020), said that organic fertiliser helps to improve soil moisture especially in the long term. For the pH, all the soil has increases pH after receive treatment except for onion husk and mixed fertiliser. Then, the temperature started to decrease where it was influenced by the fertiliser except for coffee residue that does not change.

A Kruskal-Wallis test was performed to know the effect of the fertiliser toward the plant growth along with the changes in the soil by testing the significant differences which is $p < 0.05$. From the result, the parameter of the plant growth that shows significance difference is the number of leaves while for the changes in the soil is soil pH.



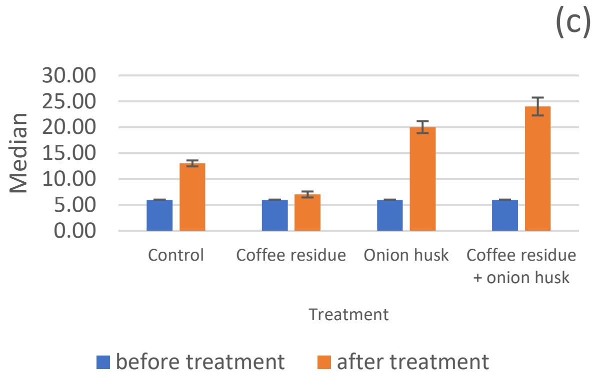


Figure 3.2 Plant growths observed before and after treatment with (a) plants height (b) leaf area and (c) number of leaves.

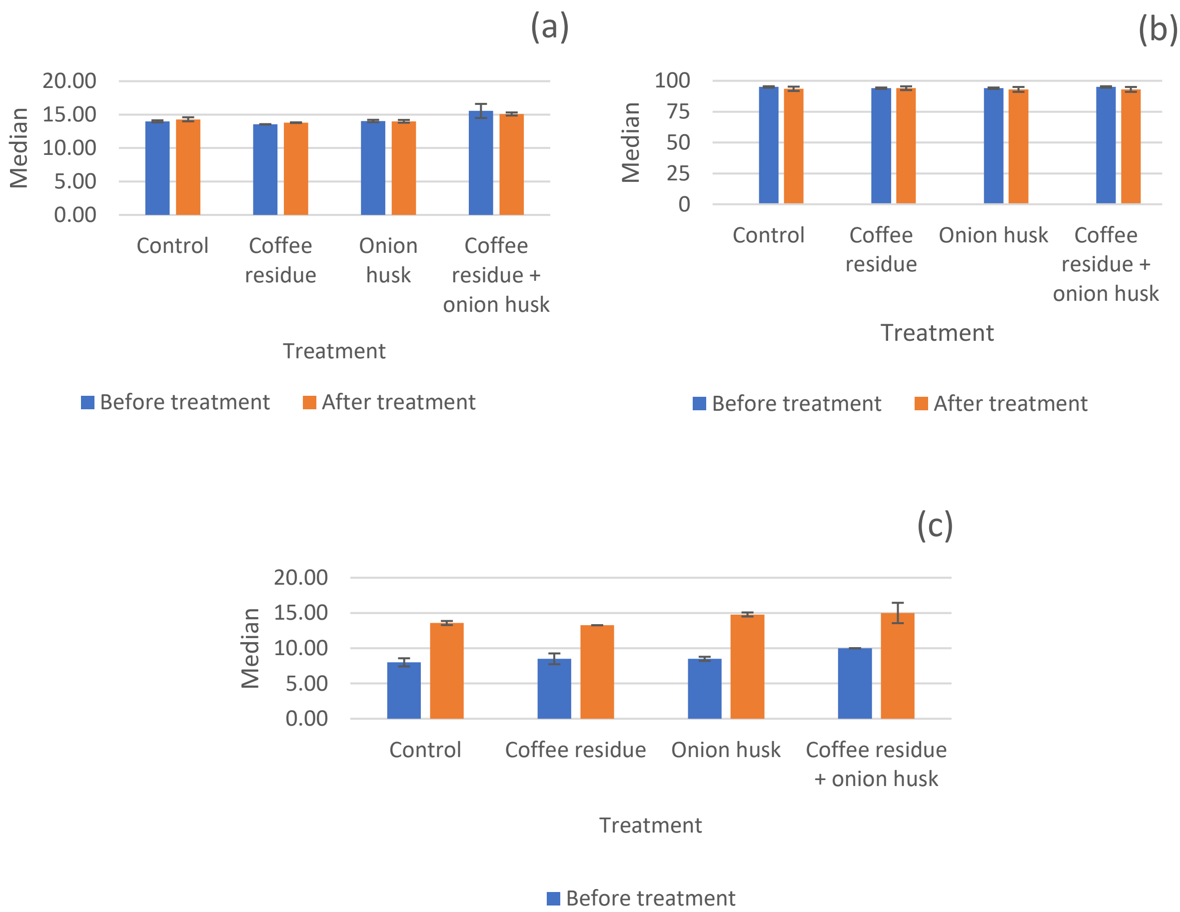


Figure 3.3 The changes in the measured soil variable before and after treatment for (a) soil pH (b) soil temperature and (c) soil moisture.

4. DISCUSSION

In the plant growth, the height of the plant and number of leaves gives significant differences after applying the fertiliser which are is liquid onion husk and mixed of onion husk and coffee residue. This indicates that fertiliser gives enough nutrient to be absorbed by the plants where it can improve plant growth. There has study stated that liquid organic fertiliser can increase the height of the plant and leaf area (Pangaribuan et.al., 2019). The nutrient that consists in the onion husk are potassium K, P, Ca and Mg that needed by the plant (Abu Bakar Sidik, et al., 2018) while the coffee residue supply nitrogen (N), one of the essential nutrients for the plant (Kasongo et. al., 2011). Besides, mixing two types of fertiliser help to increase the plant growth and reduce the inhibitory effect of caffeine in the coffee residue (Yamane, et al., 2014). The onion husk gives a negative result for the area of leaves after the treatment where the onion husk reduces the leaf area. The decreased in area of leaf can happen as the previous study faced the same issue (Anhar et.al., 2018). According to them, the reduction happened due to a high concentration of organic fertiliser that should help to increase the leaf area but it resulted to a reduction of leaf area. However, in this study the reduction happens after the plant receiving the treatment that can be the concentration of the liquid fertiliser gives effect the leaf area.

In soil parameters, soil moisture shows significant differences after the treatment. The previous study has shown that organic fertiliser can improve the soil moisture and the efficiency of crop water use (Ye et.al., 2020). The soil moisture helps the plants to increase plant growth. According to Chadha et al., (2019), moisture stress in the plants can limit the cell division and cut off the cell elongation that causes the plant maximum growth. The coffee residue is the highest among the three fertilisers. According to Kasongo (2011), all the fertiliser increases the water retention of the soil in their study. This will help the plant to retain more water for plant growth.

5. CONCLUSION

From the result, the plant growth include plant height and number of leaves has significant differences according to the types of fertilisers. The fertiliser that influences the parameters mostly dominance by onion husk and mixed fertiliser due to the essential nutrient that supply by the onion husk and coffee residue. However, the area of the leaf was dominated by coffee residue but the area also faced a reduction in area for onion husk treatment. In addition, soil moisture has significant differences among the other parameters which are soil pH and soil temperature. It proves that increases soil moisture due to increases of capability water retention of the soil. The soil temperature and soil pH does not affect by the fertiliser or the time was not enough to see the result.

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