LenteraBio
LenteraBio, 2025; Volume 14, Issue 1: 130-137
p-ISSN: 2252-3979 e-ISSN: 2685-7871
https://journal.unesa.ac.id/index.php/lenterabio/index

# Combination of Hydroponic Natural Nutrient Solution Effect on Kale Plant Growth (*Ipomoea reptans*) Using Wick System

**Muhammad Rizki Al Toriq[1]*, Rinie Pratiwi Puspitawati[1], Rizki Yulia Oxi[1], Sukistiyono[2]**
[1] Departement of Biology, Faculty Mathematics and Natural Sciences, State University of Surabaya
[2]Residents of Tanjungsari Village, Taman Sub-District, Sidoarjo District
*e-mail: muhammadrizki.19018@mhs.ac.id

**Article History:**
**Received:**
24-July-2024
**Revised:**
27-January-2025
**Available online:**
31-January-2025
**Published regularly:**
31-January-2025

**Abstract**
Synthetic AB mix nutrients pose long-term risks. Thus, it is necessary to discover alternatives, such as natural and environmentally friendly nutrient solutions. The combination of several ingredients will create a perfect nutrient solution formula for kale growth. The purpose of this study was to determine the combination of natural nutrient solutions effect and to determine the best natural nutrient combination formula for kale growth. Experimental research used a completely randomized design (CRD) with eight treatments and three repetitions. The treatment consisted of control, namely the use of synthetic AB mix nutrition and manipulation treatment using a combination of catfish waste water extract, rice washing water, banana peels, onion peels, aloe vera and bean sprouts. Data was tested quantitatively using the Anova test and Duncan's test at 5% level. The results showed that the combination of natural nutrient solutions had a significant effect on the growth of kale. Formal A produces the best formula with the composition of ingredients water (500 ml) + catfish wastewater (500 ml) + aloe vera soak (10 ml) + bean sprouts soak (10 ml). Formula A generated an average plant height of 42.7 cm in the long category, 15 leaves in the 'numerous' category, a stem diameter of 1.01 cm in the large category, a root length of 13.3 cm in the long category, and a plant wet weight of 10 g in the heavy category.

**Keywords:** agriculture; agricultural productivity; kale; nutrient combination; wick system.
**How to Cite:** Al Toriq MR, Puspitawati RP, and Oxi RY, 2025. The Combination of Hydroponic Natural Nutrient Solution Effect on Kale Plant Growth (*Ipomoea reptans*) Based on Wick System. LenteraBio; 14(1): 130-137
**DOI:** https://doi.org/10.26740/lenterabio.v14n1.p130-137

## INTRODUCTION

Indonesia is well-known as an agricultural country where most of the population are farmers. Therefore, almost the entire area is designed as agricultural land. Population growth over time, especially in dense urban areas, has forced farmland to be developed into buildings for residential use, resulting in a drastic reduction in farming land (Gultom and Harianto, 2022). The favorite vegetable among the public is kale. Indonesian market areas generally sell the land and water kale. However, people mostly prefer the land kale type. Land kale (*Ipomoea reptans* Poir) is recognized as a popular vegetable in the market because it has a savory taste. The plants are short-lived annuals that do not require a large planting area, making them suitable for cultivation in urban areas with limited space. Kale also contains vitamins A, B, C, and various essential minerals, especially iron, which are beneficial for growth and health (Julvian *et al.,* 2023). Based on BPS data (2022), kale fluctuated in production (ton/hectare) sequentially in 2020, 2021, and 2022. Per harvest area production was 312,336 tons/2374 Ha, 341,196 tons/2374 Ha, and 329,616 tons/1946 Ha. The final result in 2022 found that the production amount and the harvest area of kale plants decreased.

The lack of land and the high demand for vegetables are among the conditions that pressure people to create innovations and find alternatives. In line with the times, the field of agriculture has made progress in its cultivation system. The cultivation technique that is considered appropriate echoed to eradicate these problems, namely hydroponics. Romalasari and Sobari (2019) explained that hydroponics is a plant cultivation technique that utilizes water as a plant-growing medium. The medium has various management systems to regulate nutrients as well as oxygen. Izzuddin (2016) stated that hydroponics is recognized as a planting method without the use of soil but only uses nutrient solutions from minerals or materials that have nutrient content, such as coir, minerals, sawdust, etc.

Hydroponic technology has become an alternative for urban people with narrow yards. Among the numerous hydroponic systems, the wick system is the simplest and usable by the general public without spending a lot of capital. Based on Wibowo *et al.* (2022), the wick system is a simple hydroponic technique because it uses the role of the wick as a link between plant roots and nutrient solutions in the media. The depiction is the same as the operation of the kerosene stove wick. The roots absorb the nutrient solution through the medium of the wick. The wick is tethered to the bottom of a net pot that was inserted into rock wool planting media previously with seeds that have been planted and grown. The wick system is suitable for the general public because it is cost-effective and does not require electrical installation.

A critical factor in the hydroponic plant cultivation system is the nutrient solution that determines the final quality of the plants (Tripama and Yahya, 2018). Nutrition is the primary mechanism because it supplies water and mineral needs for plants whose dosage levels must be adjusted to the needs of the field, which will affect the quality of the final crop (Setiawan, 2018). The popular nutrient used in hydroponics is AB mix synthetic chemical fertilizer, which is very easy to obtain in the market. The amount of vegetable cultivation using hydroponic systems pressures farmers to apply synthetic chemical fertilizers, which in the future can damage the environment (Lakshitowati and Murdono, 2021). Synthetic AB mix nutrients are recognized as a synthetic chemical fertilizer that adversely impacts the environment and directly affects consumers (Wulandari *et al.*, 2023). The price of AB mix nutrients itself is relatively expensive for plant fertilizer applications. Hence, there is a need for other alternatives, such as safer and cheaper fertilizers for the community (Solikhah and Winarsih, 2019). The crucial impact of using AB mix nutrients on an ongoing basis is the presence of residues in harvest, especially fruits and vegetables that should be consumed fresh (Rasjal *et al.*, 2022).

There have been numerous studies related to hydroponic nutrient solutions, including Alfatihah *et al.*, (2023) aquaponic system of catfish pond water nutrition in kale and pak choi plants, Husna *et al.*, (2022) the use of different levels of washed rice water on kale plants, Wulansari *et al.*, (2021) combination of AB mix, POC and biofertilizer on tomato plants, Astija and Anita (2021) washed rice water on celery vegetables, Lakshitowati and Murdono (2021) AB mix nutrient solution with Biofarm commercial POC, Mukminin *et al.*, (2020) AB mix nutrients combined with pond water waste for mustard plants, Kuswoyo and Zein (2018) catfish pond water nutrition, goat urine, and AB mix on mustard plants, and Kasi *et al.*, (2018) POC hydroponic system of bamboo shoots. Most previous studies only examined one type of nutrient and did not combine the nutrients to find new nutritional formulas. However, the nutrient combination was not among the same organic nutrients, but a combination with the synthetic. The POC nutrients used in previous studies focused on fruit waste, animal feces, and animal urine. In addition to differences in nutrient combination materials, there are differences in the research objects used. The organics combination with the main ingredients of catfish wastewater, washed rice water, banana peel soak, onion skin soak, aloe vera soak, and bean sprouts soak be the renewal in this research.

According to the background of the problem, these research objectives are to understand the effect and the best combination of hydroponic natural nutrient solution formulas on the growth of kale plants. It expects that the research method applies to all hydroponic systems and all types of hydroponic plants, and the hydroponic natural nutrient solution formula can hopefully reduce the use of synthetic chemical nutrients and create environmentally friendly and zero waste conditions.

## MATERIALS AND METHODS

This research is classified as experimental research that applies the one-factorial Completely Randomized Design (CRD) with eight treatments, which are repeated three times in each them to minimize errors during data collection. It was conducted from December 2023 until February 2024. Seed sowing, planting seedlings on hydroponic media, harvesting kale plants, making nutrient solution formulas, data collection, and data processing were performed in the Greenhouse of Tanjungsari Village, Taman District, Sidoarjo Regency. The observation parameters of kale plant growth are plant height, number of leaves, stem diameter, root length, and plant wet weight. Feeding and checking the stock of nutrient solution was conducted every seven days on hydroponic media. The observations were on 28 days after planting. The selection of 28 days after planting observations refers to Kurniawan and Lestari (2020) that the main hydroponic kale vegetables can be subjected to final observations and harvesting when the plants are 27-30 days after planting. After the observation, the data was analyzed using Analysis of Variance, continued with Duncan's Multiple Range Test (DMRT) at 5% level.

This study had eight treatments, of which one treatment was used as a control and the other seven as a comparison. The control treatment used AB mix nutrients whose formula composition refers to Pangaribuan *et al.,* (2022) that the dose of nutrients per liter of water was 5 ml of nutrient A plus 5 ml of nutrient B. Researchers in determining the composition of the solution refer to research by Angraeni *et al.,* (2018) namely that the amount of water must be greater than the extract used. Research by Angraeni *et al.,* (2018) shows that liquid organic fertilizer for bamboo shoots is used in the amount of 200 ml + 200 ml of water in making a natural nutrient solution formula and the amount of extract used is adjusted to the needs and amount of water used. Through this research, the author developed the formula composition for a natural hydroponic nutrient solution with more diverse ingredients than previous researchers. Furthermore, the researcher presents the combination formula of hydroponic natural nutrient solution in Table 1 as follows:

**Table 1**. Natural nutrient solution formula

| Formula | Material Composition |
|---|---|
| A | Water (500 ml) + catfish wastewater (500 ml) + aloe vera soak (10 ml) + been sprouts soak (10 ml) |
| B | Water (1 L) + onion skin soak (10 ml) + banana peel soak (10 ml) + been sprouts soak (10 ml) |
| C | Water (500 ml) + washed rice water (500 ml) + onion skin soak (10 ml) + been sprouts soak (10 ml) |
| D | Water (500 ml) + catfish wastewater (250 ml) + washed rice water (250 ml) + been sprouts soak (10 ml) |
| E | Water (500 ml) + washed rice water (500 ml) + onion skin soak (10 ml) + aloe vera soak (10 ml) + been sprouts soak (10 ml) |
| F | Water (1 L) + onion skin soak (10 ml) + banana peel soak (10 ml) + aloe vera soak (10 ml) + been sprouts soak (10 ml) |
| G | Water (500 ml) + catfish wastewater (250 ml) + washed rice water (250 ml) + onion skin soak (10 ml) + banana peel soak (10 ml) + aloe vera soak (10 ml) + been sprouts soak (10 ml) |

Notes: The composition of the solution formula adopts research by Angraeni *et al.,* (2018).

In making the banana peel soak, about 250 g of banana peel was cut into small pieces and mixed into 1 liter of water in a plastic bucket. The mixture was fermented for a week. The same was performed using onion skin to make onion skin, aloe vera, and bean sprout soak. The catfish wastewater was taken from catfish culture, water was aged seven days old or more. About 1 liter of catfish wastewater was mixed with 2 ml of EM4, and then stored as stock nutrients. The rice water used was from three times process washing as stock.

Preparation of kale seedlings begun by soaking kale seeds for 24 hours to help the imbibition process. Next, rockwool was arranged in a plastic tray and watered until the rockwool was wet. Kale seeds were then put into rockwool with a depth of approximately 0.5 cm and stored in dark place without sunlight. After kale seeds were germinated, they were moved to tray without direct exposure to sunlight for adaptation. Adaptation was finished when the first leaf appeared with expanding conditions perfectly and adapted strongly to their environment, occurring for about a week. Then, the rockwool was moved into the net pot on the hydroponic wick system with the nutrient solution based on the research design. The nutrient solution media was shaken every morning for oxygen gas exchange in the solution.

## RESULTS

The Anova test results showed the significance value of the parameters of plant height (sig. 0.010), number of leaves (sig. 0.000), stem diameter (sig. 0.000), root length (sig. 0.008), and wet weight of plants (0.000) < α value (0.05) which indicated the effect of treatment on the growth of kale plants. Data were further tested using duncan's test at the 5% level to determine the best treatment for the growth of kale plants. Duncan's test results are presented in Table 2.

**Table 2.** Duncan test results of kale plant growth

| Treatment | Parameter | | | | |
|---|---|---|---|---|---|
| | Plant Height (cm) | Number of Leaves (cm) | Stem Diameter (cm) | Root Length (cm) | Wet Weight Plant (g) |
| **Control** | 34,00 ± 2,65a | 12,00 ± 2,00bc | 0,70 ± 0,08ab | 11,67 ± 0,58cd | 5,00 ± 1,73a |
| **Formula A** | 42,67 ± 2,52b | 15,00 ± 1,53d | 1,01 ± 0,05c | 13,33 ± 0,58d | 10,00 ± 1,00b |
| **Formula B** | 33,33 ± 4,16a | 9,00 ± 0,58ab | 0,65 ± 0,02a | 9,00 ± 2,65abc | 5,00 ± 1,00a |
| **Formula C** | 35,00 ± 3,61a | 9,00 ± 1,00a | 0,89 ± 0,03b | 11,83 ± 3,62bcd | 5,67 ± 1,53a |
| **Formula D** | 34,83 ± 4,25a | 11,00 ± 1,00abc | 0,64 ± 0,11a | 7,67 ± 0,58a | 5,00 ± 1,00a |
| **Formula E** | 31,50 ± 2,78a | 12,00 ± 1,15c | 0,69 ± 0,07ab | 10,80 ± 0,75abcd | 4,67 ± 1,15a |
| **Formula F** | 29,23 ± 1,97a | 10,00 ± 1,53abc | 0,74 ± 0,02ab | 7,27 ± 2,00a | 5,67 ± 0,58a |
| **Formula G** | 30,67 ± 5,03a | 9,00 ± 1,00a | 0,68 ± 0,07ab | 8,33 ± 1,53ab | 4,00 ± 1,00a |

Notes: All numbers followed by the same letter in the same column indicate no significant difference at the 5% level of the Duncan test. The description of the formula in the first column (treatment) refers to Table 1.

Duncan test results showed that formula A is the best formula. Formula A is significantly different from the control treatment and all formula treatments in the parameters of plant height, number of leaves, stem diameter, and plant wet weight, but formula A is not significantly different in the parameter of root length.

The observation results for 28 days after planting on hydroponic media wick system showed data that there were three different ranges of plant height. The first range is <30 cm and is the shortest kale data found in the treatment of formula F. The second range of 30-40 cm is found in the control treatment, formula B, C, D, E, F, and G. The third range is >40 cm is the treatment of formula A. The highest number of leaves is the treatment of formula A, and the least number of leaves is the treatment of formula B, C, and G. The growth of the leaves of kale plants causes the classification of the range of the number of leaves. The first range in the number of leaves <10 is the treatment of formula B, C, and G. The second range is 10-15 leaves by the control treatment, formula A, D, E, and F. The average stem diameter of kale plants in control and treated plants was 0,72 cm. the average root length of kale plants in all treatments was 9,6 cm. the average wet weight of kale plants in all treatments was 5,6 gram. The growth data of kale plants are presented in Figure 1.

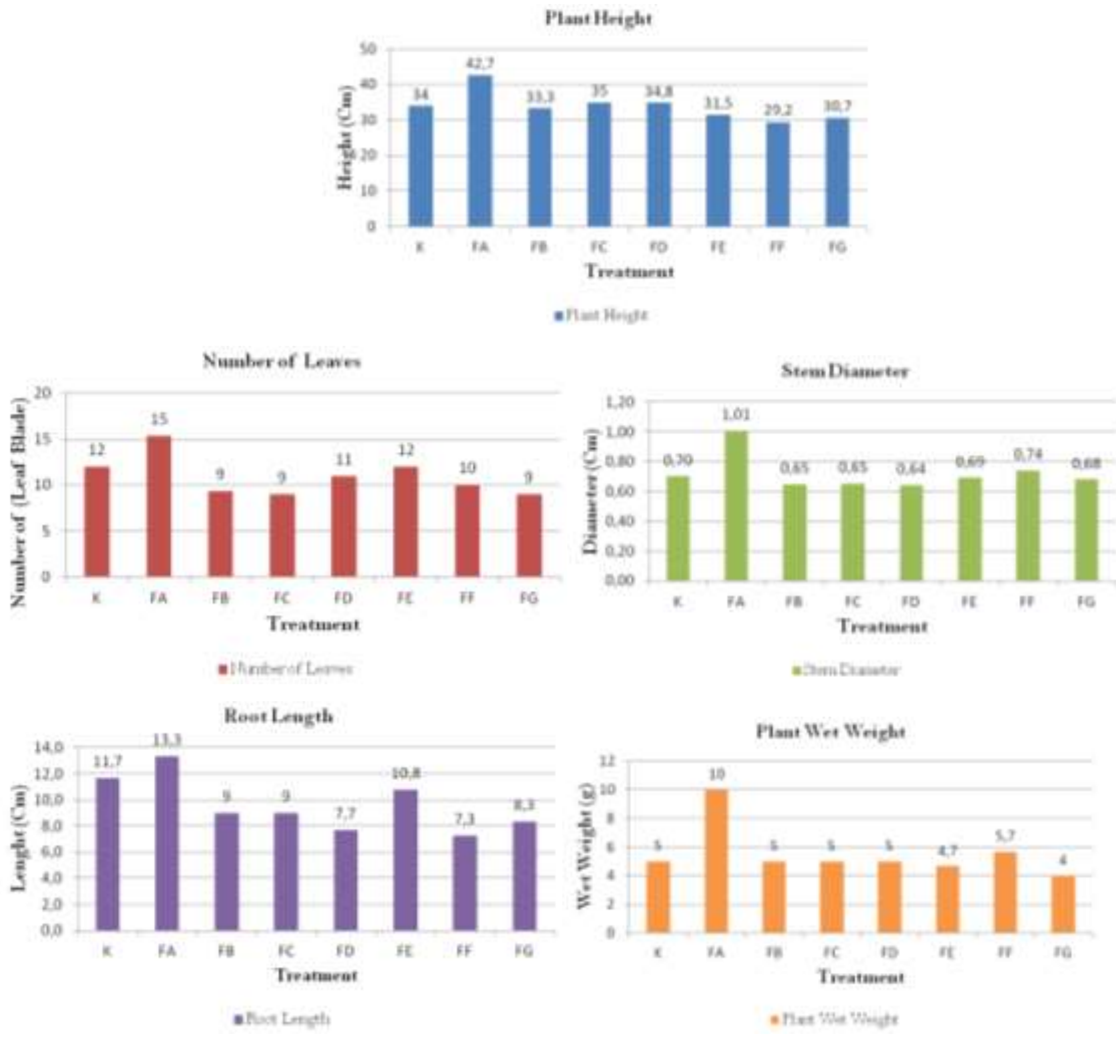


**Figure 1**. Growth data of kale plants

## DISCUSSION

The control and treatment plants retrieved growth without significant obstacles due to the homogeneous environment. The wick hydroponic system shows that simple hydroponics can produce good-quality plants without excessive costs and does not require electricity. Environmental conditions found in the greenhouse include an average TDS of 1102 ppm, pH of 6.4, humidity of 66%, temperature of 28$^{o}$C, and light intensity of 8340.00 lux. The environmental conditions obtained are following the standard conditions for hydroponic systems. Based on Sotyohadi *et al*., (2020) the nutrient solution used in hydroponic systems should have a pH range of 5.5-6.5 and a TDS range of 1050-1200 ppm. Fadhlillah *et al*., (2019) stated that the environmental temperature and hydroponic nutrient solution in kale plants are should in the range of 25-30$^{o}$C, humidity> 60%, and optimal light intensity in the range of 4305, 56 lux-8611.13 lux.

The nutrient content of the AB mix nutrients is highly complete. The nutrients contained in natural ingredients are not as complex as AB mix nutrients, but if combined, they will complement each other. Some ingredients even have growth regulators in the form of auxins and cytokines that play a role in plant roots and leaves growth. Sulistyowati and Nurhasanah (2021) stated that the AB mix contains macronutrients, including N, P, K, Ca, Mg, and S, and micronutrients include Cu, Mn, Zn, and Fe. Sriwahyuni *et al.,* (2023) clarified that banana peels contain N, P, K, Ca, Na, Mg, and Zn nutrition. Ernis *et al*., (2023) claimed that onion skins, especially shallots, contain macronutrients of N, P, K, and C-organic and micronutrients of Fe, Mn, and Cu. Shallots also have the content of growth regulators auxins and cytokinins. Salim *et al*., (2021) aloe vera have macro and micro contents including Ca, K, Mg, Zn, Mn, and Na. Safitri *et al*., (2023) stated that bean sprouts have great nutrient content to support plant growth and production of N, P, K, Ca, Mg, and S. Bean sprouts contain the natural growth regulators, namely gibberellins, auxins, as well as cytokinins. Jannah *et al.,* (2018) stated that washed rice water contains essential elements, such as N, P, Ca, Mg, S, Fe, and vitamin B1. Gusnawan *et al.,* (2021) said that catfish wastewater comes from feces and fish urine that contains N, P, K, and C-organic.

The height of kale plants in the control plants with synthetic AB mix nutrients produces an average height of 34 cm, which can be outperformed by formula A with the composition of water (500 ml) + catfish wastewater (500 ml) + aloe vera soak (10 ml) + bean sprouts soak (10 ml) with the final observation of the average plant height of 42.7 cm (Figure 1). Formula A is the best natural nutrient solution formula that can optimize the growth of kale plants. The nutrient content carried by catfish wastewater combined with aloe vera nutrients and the role of growth regulator hormones auxin and cytokinin from the bean sprouts soak caused the kale plant height to get longer. Auxin from the bean soak stimulates the roots to grow and absorb nutrients, then channel to the stem to the leaves. Meanwhile, cytokinin stimulates the kale plant to multiply the leaves. The nutrients absorbed will make the kale plant stem elongate and potentially produce stem nodes where the leaves come out. According to Sarah *et al.,* (2023), bean sprouts contain ZPT auxin, which stimulates cell division towards plant growth and roots to grow, while cytokinin stimulates plants to produce leaves. The height of kale plants is included in the normal category when reviewing the diagram data (Figure 1) because the height of almost the entire formula can compensate for AB mix nutrients even though there is a slight difference in size. Based on Figure 1, the height of kale plants is classified into three parts: plant height < 30 cm as 'less long,' 30 cm - 40 cm as 'long,' and > 40 cm as 'very long.' The diagram (Figure 1) shows that formula F is included in the 'less long' due to several factors that can affect, for instance, the composition of the formula, which is too much causes growth disorders. Tripama and Yahya (2018) stated that inappropriate nutrition is qualified to disrupt plant production. However, formula F is still in good condition because it almost touches the 30 cm mark, which means there is no drastic decrease in the average value. The provision of water in the formula is intended for dilution media so that the solution is not too concentrated. Likewise, the allotted dose of 10 ml in each soak is aimed to compensate for the results of AB mix synthetic nutrients, which means that it takes twice the dose of natural nutrients to match the results of AB mix synthetic nutrients or at least with the same level in one hydroponic nutrient mixing.

The leaves of kale control plants obtained an average of 12 strands. This number can be balanced by the average number of leaves from Formula A with 15 strands. Some natural formulas produced a lower average leaves number than the control plants, with a difference of 3 leaves at most. Some influencing factors are the internal factors from the plant itself, such as the length of the kale plant. The longer the kale plant, the more potential it is to produce nodes where the leaves appear, and the nutrients absorbed by the plant in good condition will respond morphologically by showing that the plant is growing (picture 1), marked by the appearance of numerous nodes on the kale stem. The N content of the formulas is appropriate because plants need N for leaf formation. However, this role is also affected by the auxin and cytokinin ZPT levels. Tripama and Yahya (2018) claimed that plants during the vegetative period, especially vegetable plants whose leaves are needed, require an optimum N element to stimulate leaf growth. Related to the diagram in Figure 1, the leaves of kale plants are classified into three groups; <10 strands including 'few', 10 - 15 strands including 'numerous', and > 15 strands including 'heavily'. In general, four formulas of natural nutrient solutions from eight formulas fall into the 'numerous' category, which means they can balance AB mix nutrients.

The diameter of the kale stem in Figure 1 shows that Formula A has the widest average stem diameter among the control plants with other formula treatments. Generally, the overall average diameter of kale stems is above 0.60 cm. Formulas A and F can outperform the control plants, while the other formulas have a difference that is not too much with the control plants. It shows that natural nutrients compensate for synthetic AB mix nutrients. The diameter of the kale stem is affected by the plant factor itself, namely the relationship between parameters. The diameter of the stem gets greater if the kale plant has a high and long condition. It is to help support the stem with a high number of leaves so that the plant does not fall and break. Another factor is the nutrient sufficiency factor. If the nutrients are sufficient, the distribution of nutrient uptake will appear in the appearance of large kale stems that are fresh green without the yellow color of wilting and stems that do not shrink. Related to the diagram in Figure 1, kale stem diameter is divided into three categories; < 0.07 cm is 'less wide', 0.07 cm - 1 cm is 'wide', and >1 cm is 'very wide'. The optimum consumption standard is kale with a stem diameter of 0.7 cm-1 cm because it has a crunchy texture. If the diameter of the kale stem is above 1 cm, the kale is hard and old, so it is not recommended for consumption.

The average root length of all treatments above 7 cm for all formulas has not been able to balance for the average root length of AB mix nutrients except formula A. Formula A, with an average root length of 13.3 cm, has a slight difference with AB mix nutrients control plants with an average of 11.7 cm. Based on the diagram data in Figure 1, the root length of kale plants is classified into three categories; < 10 cm is'short', 10-15 cm is 'long', and > 15 cm is 'very long'. Root length is affected by the nutrients contained in the nutrient solution. The more concentrated a nutrient is, the more roots will be distracted from absorbing the nutrient, which results in disrupted growth. Roots that do not absorb nutrients appropriately may affect other plant organs, such as the leaves reducing, stems shrinking, and yellowing. The levels of auxin and cytokinin carried by the onion soak and bean sprouts soak in formulas B, C, F, and G (Table 1) caused an excess of growth regulators that affected growth. Meanwhile, formulas D and G (Table 1) show a combination of catfish wastewater and washed rice water, which generally have larger particles due to residue from fish feces and rice crumbs. This case makes it difficult for the roots to absorb nutrients. In addition to the larger particle size, if the two materials are left unattended for too long, they precipitate, and the nutrient solution is unmixable throughout the area. As a result, it is difficult for plant roots to reach, and the nutrients obtained by each plant are different. Furthermore, formulas with more than three ingredients combined generally have an average root that tends to be short because of the concentration of nutrients. Surtinah and Lidar (2017) stated that nutrient solutions that are too thick or even concentrated can cause growth disorders in plants because the roots cannot absorb nutrients.

The wet weight of kale plants shows that formula A has the heaviest average among all treatments, both natural nutrient solutions formula and AB mix nutrients. The wet weight of plants produced by formula A was twice that of plants generated by AB mix nutrients. This case indicates that the composition of the formula is adequate and can compete with the quality of the AB mix. Formulas B, C, D, and F have the same weight as the control plants, which indicates that the four formulas can compensate for the AB mix. However, two formulas produce a weight below the standard of the control plants, namely formulas E and G, which are slightly different from the average of the control plants. The wet weight is affected by both internal and external factors. Internal factors come from the kale plants themselves, related to plant height, number of leaves, stem diameter, and root length. The taller the kale plant, accompanied by numerous leaves and a large stem diameter and supported by long roots, the higher the wet weight, indicating the quality of the kale. External factors come from environmental conditions and nutrition. The environmental conditions of kale plants are appropriate and suitable, so there are no problems. Problems arise when more materials are combined with the original growth regulator innate from the material. There is a buildup or excess of nutrients resulting in the nutrient conditions becoming concentrated and complex to absorb by plant roots. According to Surtinah and Lidar (2017), nutrient solutions that are too thick or concentrated can cause growth disturbances because the roots are not qualified to absorb nutrients. According to the diagram (Figure 1), the wet weight of kale plants is divided into three categories; <6 g/plant 'light' is weight, 6-10 g/plant is 'heavy' weight, and >10 g/plant is 'very heavy' weight. The wet weight of the plant itself is calculated per unit plant, not weighed in a bundle with a lot of kale filling (bundle).

Referring to the research of Oktavia *et al*., (2022) stated that the minimum kale plant height to be harvested is 25 cm. Based on the diagram data (picture 1), the quality of kale plants that are good for consumption is with the physical condition of plant height between 30-40 cm or >40 with 10 - 15 leaves/plant, stem diameter 0.7 - 1cm, root length 10 - 15 cm, and wet weight 6-10g/plant. The standard is based on optimum and healthy plant growth with strong and long roots, then the nutritional needs of the kale are sufficient and produce tall growing stems with many leaves accompanied by regular stem diameter, not too old and not too young. It is based on optimum and healthy plant growth with strong and long roots so that the nutritional needs of the kale are sufficient, resulting in a tall growing stem with many leaves at once with the standard diameter of the stem. Plants do not experience root rot, wilting, yellowing, drying, and curling leaves, no holes due to pests, and no shrinkage. Not all kale plants with more than 40 cm have numerous leaves. This case depends on the absorption of nutrients by the roots and distribution to all plant organs and the environmental conditions. There are two types of count parameters for kale leaf blades. There is a condition of tall kale with few leaves because the nodes produced by the stem are long-spaced, and the number of nodes is few, so the leaves produced are few. Otherwise, the condition of tall kale with a large number of leaves has a shorter and closer node distance, so the number of leaves produced is numerous.

## CONCLUSION

The combination of hydroponic natural nutrient solutions significantly affects the growth of kale plants in terms of plant height parameters, number of leaves, stem diameter, root length, and plant wet weight. The best and optimum combination of natural nutrient solution formulas for the growth of hydroponic kale plants based on the wick system is Formula A with the composition of water (500 ml) + catfish wastewater (500 ml) + aloe vera soak (10 ml) + bean sprouts soak (10 ml). Formula A produces an average plant height of 42.7 cm in the 'Long' category, leaves of 15 strands in the 'Numerous' category, a stem diameter of 1.01 cm in the 'Wide' category, a root length of 13.3 cm in the 'Long' category, and plant wet weight 10 g in the 'Heavy' category.

## ACKNOWLEDGEMENTS

Thanks to the residents of Tanjungsari Village, Taman Sub-District, Sidoarjo District in their efforts to help prepare research land, research tools and materials, to help care for and protect kale plants from anything that can damage plants.

## REFERENCES

Alfatihah A, Latuconsina H and Prasetyo HD, 2023. Pertumbuhan Tanaman Kangkung (*Ipomoea reptans* Poir) dan Pakcoy (*Brassica rapa* Linnaeus) pada Sistem Budidaya Akuaponik. *Jurnal Riset Perikanan Dan Kelautan* 5 (2): 88-97.

Angraeni F, Kasi PD, Suaedi and Sanmas S, 2018. Pemanfaatan Pupuk Organik Cair Rebung Bambu Untuk Pertumbuhan Kangkung Secara Hidroponik. *BIOSEL (Biologi Science & Education)* 7 (1): 42-48

Astija A and Anita A, 2021. Pengaruh Penggunaan Limbah Air Cucian Beras terhadap Pertumbuhan Tanaman Seledri (*Apium graveolens* L.) dengan Sistem Penanaman Hidroponik. *Bioscientist: Jurnal Ilmiah Biologi* 9 (1): 105-113.

Badan Pusat Statistik, 2022. Produksi Tanaman Sayuran Menurut Provinsi dan Jenis Tanaman. Badan Pusat Statistik, 2022. Produksi Tanaman Sayuran Menurut Provinsi dan Jenis Tanaman. https://www.bps.go.id/api/statistics-table/3/ZUhFd1JtZzJWVVpqWTJsV05XTllhVmhRSzFoNFFUMDkjMw==/produksi-tanaman-sayuran-menurut-provinsi-dan-jenis-tanaman--2022.html?year=2022 , diakses pada 02 Agustus 2024, pukul 19.44.

Ernis G, Mala DS, Okta A, Notriawan D and Fadila MA, 2023. Nutrition Levels of Liquid Organic Fertilizer from Onion Skin (*Allium cepa* L) with EM-4 Bioactivator. *JURNAL SAINS NATURAL* 13 (2): 73-80.

Fadhlillah RH, Dwiratna S and Amaru K, 2019. Kinerja Sistem Fertigasi Rakit Apung Pada Budi Daya Tanaman Kangkung (*Ipomoea reptans* Poir.). *Jurnal Pertanian Tropik* 6 (2): 165-179.

Gultom F and Harianto S, 2022. Lunturnya Sektor Pertanian di Perkotaan. *Jurnal Analisa Sosiologi* 11 (1): 49-72.

Gusnawan R, Indrawanis E and Okalia D, 2021. Pengaruh Air Limbah Kolam Ikan Lele terhadap Pertumbuhan dan Produksi Tanaman Melon Kuning (*Cucumis melo* L.). *Green Swarnadwipa: Jurnal Pengembangan Ilmu Pertanian* 10 (2): 260-267.

Husna A, Susilawati CDN, Gunawan Y, Aziz PA and Widiyanti A, 2023. Pemberian Limbah Air Cucian Beras Terhadap Pertumbuhan Tinggi Tanaman Kangkung Darat (*Ipomea reptans* Poir). *Indonesian Journal of Engineering (IJE)* 3 (1): 34-48.

Izzuddin A, 2016. Wirausaha Santri Berbasis Budidaya Tanaman Hidroponik. *DIMAS: Jurnal Pemikiran Agama untuk Pemberdayaan* 12 (2): 351-366.

Jannah N, Yuliani Y and Rahayu Y, 2018. Penggunaan Pupuk Cair Berbahan Baku Limbah Air Cucian Beras Dengan Penambahan Serbuk Cangkang Telur Terhadap Pertumbuhan Tanaman Sawi Hijau (*Brassica juncea*). *LenteraBio: Berkala Ilmiah Biologi* 7 (1):15-19.

Julvian E and Waworuntu JSS, 2023. Pengaruh Pengaturan Pemberian Dosis Pupuk Organik Cair Super Grow dan Pupuk Kompos Terhadap Pertumbuhan Dan Hasil Kangkung Darat Bangkok LP-1. *SEIKO: Journal of Management & Business* 6 (1): 126-137.

Kasi PD, Suaedi S and Angraeni F, 2018. Pemanfaatan Pupuk Organik Cair Rebung Bambu untuk Pertumbuhan Kangkung Secara Hidroponik. *BIOSEL (Biology Science and Education): Jurnal Penelitian Science dan Pendidikan* 7 (1): 42-48.

Kurniawan A and Lestari HA, 2020. Sistem Kontrol Nutrisi Floating Hydroponic System Kangkung (*Ipomea reptans*) Menggunakan Internet of Things Berbasis Telegram. *Jurnal Teknik Pertanian Lampung* 9 (4): 326-335.

Kuswoyo A and Zein M, 2018. Kajian Pemanfaatan Air Kolam Lele dengan Sunstitusi Urin Kambing Sebagai Nutrisi Hidroponik Sayuran Organik. *AGRISAINS* 4 (1): 1–4.

Lakshitowati CTC and Murdono D, 2021. Pengaruh Pemberian Pupuk Organik Cair Komersial Biofarm dengan Pembanding AB-mix pada Budidaya Sawi Pakcoy (*Brassica rapa* subsp chinensis) Secara Hidroponik Teknik Rakit Apung. *Jurnal Triton* 12 (1): 10-19.

Mukminin A and Sutanto A, 2020. Pemberian Nutrisi Ab Mix Pada Limbah Air Kolam Dengan Menggunakan Sistem Hidroponik Berpotensi Meningkatkan Pertumbuhan Tanaman Sawi (*Brassica juncea* L). *Biolova* 1 (1): 41-47.

Oktavia AI, Suarman DF, Rifyant FA, and Fevria R, 2022. Aplikasi Sistem Hidroponik Film Technique (NFT) Pada Budidaya Tanaman Kangkung (*Ipomea* sp.). *Serambi Biologi* 7 (2): 157-162.

Pangaribuan DH, Ginting YC, Rugayah R, Sanjaya P, Karyanto A, Dewi KC and Sari IP, 2022. Teknik Fermentasi Campuran Bahan Organik Sebagai Sumber Nutrisi Organik pada Sayuran Sawi yang Ditanam dengan Hidroponik. *Kultivasi* 21 (3): 305-317.

Rasjal R, Haris A and Boceng A, 2022. Respon Tanaman Selada (*Lactuca sativa* L) Terhadap Berbagai Macam Pupuk Organik yang Ditanam pada Dua Periode Tanam. *AGrotekMAS Jurnal Indonesia: Jurnal Ilmu Peranian* 3 (3): 102-113.

Romalasari A and Sobari E, 2019. Produksi Selada (*Lactuca sativa* L.) Menggunakan Sistem Hidroponik dengan Perbedaan Sumber Nutrisi. *Agriprima: Journal of Applied Agricultural Sciences* 3 (1): 36-41.

Safitri N, Darmawati D, Khaeriyah A, Sambu A and Wahyu F, 2023. Growth And Production Of Seaweed Caulerpa Lentillifera With Microorganism Liquid Organic Fertilization Local (MOL) From bean Sprouts. *Barakuda'45* 5 (1): 96-101.

Sarah S, Nurcahyani E, Handayani TT and Mahfut M, 2023. Respon Pemberian Ekstrak Tauge (*Vigna radiata* (L.) R. Wilczek) pada Medium Murashige And Skoog Terhadap Pertumbuhan Eksplan Sawi Hijau (*Brassica rapa* var. parachinensis L.) In Vitro. *BIOMA: JURNAL BIOLOGI MAKASSAR* 8 (2): 88-95.

Setiawan ND, 2018. Otomasi Pencampur Nutrisi Hidroponik Sistem NTF (Nutrient Film Technique) Berbasis Arduino Mega 2560. *Jurnal Teknik Informatika UNIKA Santo Thomas* 3 (2): 78-82.

Sholikhah I and Winarsih, 2019. Pengaruh Pemberian Pupuk Cair Organik dan Pupuk Cair Kimia terhadap Pertumbuhan Tanaman Sawi (*Brassica juncea* L.) dengan Metode Hidroponik Sistem Wick. *LenteraBio: Berkala Ilmiah Biologi* 8 (3): 190-195.

Sotyohadi DWS and Somawirata IK, 2020. Perancangan Pengatur Kandungan TDS dan PH pada Larutan Nutrisi Hidroponik Menggunakan Metode Fuzzy Logic. *ALINIER: Journal of Artificial Intelligence & Applications* 1 (1): 33-43.

Sriwahyuni S, Oktarina H and Chamzurni T, 2023. Pengaruh Bioaktivator dalam Pupuk Organik Cair Kulit Pisang untuk Mengendalikan Penyakit Layu Fusarium pada Tanaman Tomat (*Solanum lycopersicum*). *Jurnal Ilmiah Mahasiswa Pertanian* 8 (1): 438-452.

Sulistyowati L and Nurhasanah N, 2021. Analisa Dosis AB Mix Terhadap Nilai TDS Dan Pertumbuhan Pakcoy Secara Hidroponik. *Jambura Agribusiness Journal* 3 (1): 28-36.

Surtinah S and Lidar S, 2017. Zat Pengatur Tumbuh dalam Nutrisi Hidroponik pada Pertumbuhan dan Hasil Tanaman Pakchoy (*Brassica rapa*). *Jurnal Penelitian Pertanian Terapan* 17 (3): 182-185.

Tripama B and Yahya MR, 2018. Respon Konsentrasi Nutrisi Hidroponik Terhadap Tiga Jenis Tanaman Sawi (*Brassica juncea* L.). *Agritrop: Jurnal Ilmu-Ilmu Pertanian (Journal of Agricultural Science)* 16 (2): 237-249.

Wibowo AS, Suprianto AN and Al-Iksan YE, 2022. Teknik Budidaya Hidroponik dengan Sistem Wick. *Science Contribution to Society Journal 2 (2): 13-18.*

Wulandari CA, Kusumaningrum RNA and Widiwurjani, 2023. Pengaruh Perbandingan Konsentrasi Pupuk Cair dan Jenis Media Tanam Terhadap Pertumbuhan dan Hasil Tanaman Tomat Cherry (*Solanum lycopersicum*) Pada Sistem Hidroponik NFT. *AGRIUM: Jurnal Ilmu Pertanian 26 (2): 133-142*.

Wulansari NK, Windriyati RDH and Kurniawati A, 2021. Pengaruh Formulasi Nutrisi Terhadap Pertumbuhan dan Hasil Tomat Ceri pada Sistem Hidroponik Tetes. *AGRIN: Asosiasi Agroindustri Indonesia* 25 (1): 36-47.