El-Hayah Vol. 9, No.3 (2023) 116-125

El-Hayah

JURNAL BIOLOGI

Journal Homepage: http://ejournal.uin-malang.ac.id/index.php/bio/index

e-ISSN: 2460-7207, p-ISSN: 2086-0064

Original research article

THE EFFECT OF ORGANIC CASGOT FERTILIZER ON PLANT GROWTH AND CHLOROPHYL LEVELS OF PAKCHOY (*Brassica rapa L.*)

Multazimatul Karimah, Azizatur Rahmah*, Berry Fakhry Hanifa

Department of Biology, Faculty of Science and Technology, State Islamic University, Maulana Malik Ibrahim, Malang

*Corresponding author

Email: *aziza_biologi@bio.uin-malang.ac.id*

DOI: 10.18860/elha.v9i3.28420

Article Info

Article history:

Received 13 June 2023

Received in revised form 27 August 2023

Accepted 29 September 2023

Key Word:

casgot fertilizer

chlorophyll

nutrients

pakchoy

plant growth

Abstract

Casgot is one of the organic fertilizers resulting from the bioconversion process of organic waste by maggots and has great potential to provide additional nutrients for Pakchoy. Pakchoy (Brassica rapa L.) is a herbaceous plant with high economic value and market opportunities and a fast growth time. Optimal pakchoy growth is influenced by chlorophyll levels. The nutrient content in casgot will increase chlorophyll formation resulting in increased pakchoy growth. The purpose of this study was to determine the effect of casgot on plant growth and chlorophyll levels of pakchoy. This research uses descriptive quantitative with a completely randomized design (CRD). The treatments in this study consisted of K1 (positive control), K2 (negative control), A1 (mixed casgot 100 g), A2 (mixed casgot 150 g), B1 (rice casgot 100 g), B2 (rice casgot 150 g), C1 (vegetable casgot 100 g) and C2 (vegetable casgot 150 g). The data analysis used was ANOVA followed by DMRT 5% (Duncan Multiple Range Test) using SPSS. The results showed that the best quality of C, N, P, K and Mg came from casgot with mixed nutrient sources that met the SNI. The treatment of casgot A2 (150 g mixed) gave the best results in all the observed parameters, namely number of leaves (19.66), leaf area (109.68 cm), plant height (24.50 cm), fresh weight (197 g), dry weight (13.66) g, and chlorophyll content (73.12 ppm) and gave an equivalent effect to the control treatment with urea.

1. INTRODUCTION

Fertilizer is an alternative in improving the quality and productivity of plant growth by providing an additional source of supply of essential nutrients in the growing medium to meet the nutrient needs of plants [1].

The use of maggot has high potential and is an innovative solution in overcoming the problem of waste accumulation in Indonesia and producing organic fertilizer that can be used to increase plant growth [2]. One of the products from the utilization of maggot bioconversion *which* is *useful as fertilizer* to support the nutrient needs of plants is kasgot (former maggot) [3].

Kasgot (Black Soldier Fly Larvae Frass) is the residue of the bioconversion process of organic waste by maggot into biomass which functions as a fertilizer that can provide additional nutrients for plants [4]. This fertilizer has the potential to be used in supplying and meeting the needs of additional nutrients in crop cultivation and plays a role in overcoming organic waste [5].

Several studies have shown that the nutrient content in kasgot meets SNI standards. Kasgot contains nutrients N 2.297-3.744%, P 3.387%, K 5.090-9.744%, and C-organic 39.08-47.46% [6]. Vegetable waste cassava has a C-organic content of 17.82%, N 0.92%, P 0.51%, and K 1.98%. Rice waste cassava has a C-organic content of 23.92%, N 5.39%, P 0.62%, and K 0.69%. Mixed waste cassava has a C-organic content of 22.55%, N 2.25%, P 0.55%, and K 18.07% [3].

Kasgot is not only rich in nutrients, but also contains amino acids, microorganisms, hormones, and enzymes that can support plant growth and quality [7]. The use of kasgot organic fertilizer has been used on several plants, namely kailan (*Brassica oleracea*) [3], mustard greens [8], and spinach (*Amaranthus tricolor*) [9].

Pakcoy is a herbaceous plant [10] whose growth process requires a lot of water [11]. Pakcoy has a high selling value and market opportunities, so the productivity and quality of its plants must be considered and improved [12]. In addition, pakcoy can grow in various weather conditions and is resistant to rain, and can be planted at various altitudes [13]. Pakcoy has a relatively short life cycle, making it a suitable subject for research to evaluate the effectiveness of various fertilizers. This is in line with Kusnia [38] research, farmers can quickly observe the response of pakcoy plants to various types of fertilizers, one of which is to determine the effectiveness of kasgot fertilizer on plant growth and quality [14].

The quality of plant growth is influenced by chlorophyll. Chlorophyll is a green pigment found in plants and plays an important role in photosynthesis [15] Increasing productivity and chlorophyll levels of pakcoy can be done through fertilization, one of which uses fertilizer. Nutrients in kasgot fertilizer can help in producing chlorophyll needed by plants for photosynthesis [16].

The increase in nutrient supply received by pakcoy will affect the increase in chlorophyll concentration per unit leaf area [17]. High chlorophyll content in the leaves will trigger an increase in the photosynthesis process, and will also increase the process of plant growth and development such as the number of leaves, leaf area, plant height, fresh weight, dry weight, and other production results [18].

2. MATERIALS AND METHODS

Study subjects

This research was conducted in December 2023 - February 2024 at the *green house of* Maulana Malik Ibrahim State Islamic University Malang. This research is an experimental research. The research design used was a completely randomized design. The treatment in this study consisted of positive control, negative control, and 3 variations of nutrient sources of kasgot fertilizer with 2 levels of kasgot treatment consisting of 3 replications so that 24 experimental units were obtained.

Making Cassava Fertilizer

The process of making kasgot begins with preparing maggot larvae seeds first and putting them in a box that already contains sawdust and organic waste (vegetables (box 1), rice (box 2), mixture (box 3)). Feeding is done by adjusting the needs and age of the maggot. Harvesting time of maggot is done at the age of 30 days. After harvesting, sieving is carried out on the former maggot and cleaned from the remaining food that is not digested by the maggot and cleaned from the remaining maggot left behind. Then the spent maggot is stored in a container and labeled. After that, the spent maggot is dried in the sun until dry.

Nutrient Content Analysis of Kasgot

C-organic cassava using the Walkley & Black method, nitrogen (N) using the distillation and titration method, phosphorus (P) and potassium (K) using a spectrophotometer in the Soil Laboratory of the Bedali-Lawang Agribusiness Development Unit for Food Crops and Horticulture and magnesium (mg) using AAS in the Chemistry Laboratory of UIN Malang.

Preparation of Planting Media

The planting media used in this study were soil and husk charcoal in a ratio of 3: 1.

Giving Treatment

The treatment was carried out by mixing the prepared planting media with kasgot organic fertilizer according to the treatment level in the research design. Each polybag that contains planting media (a mixture of soil and husk charcoal 3:1) that has been mixed with casgot casgot organic fertilizer (100 grams and 150 grams casgot mixture, rice, and vegetables) is labeled to facilitate the observation process. The casgot fertilizer treatment was carried out once during the observation process, namely at the initial stage of planting.

Planting

Planting pakcoy seedlings is done in 25x25 cm polybags that already contain plant media. Each polybag contains 1 pakcoy mustard.

Harvest

Harvesting is done after the plants are 35 Days after planting (DAP) with the criteria that the plants have formed stumps, the height of the plants is between 20-30 cm, the leaves are dark green, the leaf reinforcement has widened and the width of the leaves is 10-15 cm.

Observation

Parameters observed included number and area of leaves, plant height fresh weight, dry weight of pakcoy and chlorophyll content using Chlorophyll Meter

3. RESULTS and DISCUSSION

The results showed that the application of kasgot fertilizer at different concentrations had a significant effect on pakcoy growth parameters such as the number of leaves, leaf area, plant height and fresh weight, dry weight and chlorophyll content of pakcoy (Table 4.1).

Table 1. Effect of kasgot organic fertilizer on the growth and chlorophyll content of pakcoy (*Brassica rapa* L.)

Treatment	Observation Parameters					
	Number of leaves	Leaf area (cm^2)	Plant Height (cm)	Fresh weight (g)	Dry weight (g)	Chlorophyll Content (mg/g)
K1 (Control +)	21,33f	106,34f	24,83d	206f	14,66e	75,54f
K2 (Control -)	14a	42,11a	19,66a	58,66a	3,66a	32a
A1 (100 g)	17,33d	81,10d	23bc	128,66c	6.66bc	48,79d
A2 (150 g)	19,66e	109,68f	24.50cd	197f	13,66e	73,12f
B1 (100 g)	15.33bc	58,30c	22b	101b	5.33ab	38,0b
B2 (150 g)	18,66e	90,61e	24.16cd	182e	9,66d	58,54e
C1 (100 g)	14.33ab	52b	19,83a	60a	5.33ab	35,30b

C2 (150 g)	16.33cd	80,18d	20a	147,66d	8.66cd	41,42c

Description: K (control), A (mixed cassava), B (rice cassava), and C (vegetable cassava). Numbers in one column and row followed by the same letter or notation show no significant difference in the 5% DMRT test.

The number of pakcoy leaves ranged from 14 to 21 where the highest number of leaves was obtained in the positive control. However, the best kasgot treatment was found in mixed kasgot which was not significantly different from rice kasgot (Table 4.1). The resulting leaf area of pakcoy ranged from 42.11 cm^2 to 109.68 cm^2 where the highest leaf area was obtained in the mixed cassava treatment (Table 4.1) and the lowest number of leaves was in the negative control treatment (Table 4.1).

Pakcoy height in the study results ranged from 19.66 cm to 24.83 cm where the highest plant height was obtained in the positive control (Table 4.1). However, the best kasgot treatment was found in mixed kasgot which was not significantly different from the positive control and significantly different from the negative control (Table 4.1).

The results of pakcoy fresh weight ranged from 58.66 grams to 206 grams where the fresh weight was obtained in the positive control. However, the best kasgot treatment was found in mixed kasgot which was not significantly different from the positive control and significantly different from the negative control (Table 4.1).

The results of pakcoy dry weight ranged from 3.66 grams to 14.66 grams where the highest dry weight was obtained in the positive control. However, the best kasgot treatment was found in mixed kasgot which was not significantly different from the positive control and significantly different from the negative control (Table 4.1).

Pakcoy chlorophyll levels ranged from 32 mg/g to 75.54 mg/g where the highest chlorophyll levels were obtained in the positive control. However, the best kasgot treatment was found in mixed kasgot which was not significantly different from the positive control and significantly different from the negative control (Table 4.1).

4. DISCUSSION

Plant growth and chlorophyll levels of pakcoy are influenced by the availability of nutrients in kasgot. Mixed cassava in this study gave the highest growth results in all observation parameters. This is because mixed cassava has the highest average nutrient content, namely C-organic 15.30%, N 4.17%, P 2.50%, K 2.10%, and Mg 42.32 mg/kg compared to rice cassava C-organic 16.06%, N 3.89%, P 2.10%, K 1.90%, and Mg 26.04 mg/kg and vegetables C-organic 13.95%, N 2.65%, P 2.19%, K 1.36%, and Mg 16.00 mg/kg.

Rice organic waste is rich in carbohydrates but few vitamins and minerals. Vegetable waste is rich in minerals, fiber, and vitamins, but little protein.

Mixed cassava, from organic rice waste, vegetable scraps, and protein and fat-rich meat waste, has significant potential to enhance plant growth. Carbohydrates from rice waste serve as a primary energy source, fueling vegetative growth. Minerals from vegetables, such as nitrogen, phosphorus, and potassium, play crucial roles in chlorophyll formation, root development, and protein synthesis. Meanwhile, protein from meat waste provides essential amino acids required for plant tissue construction. This balanced nutrient combination not only accelerates plant growth but also improves crop quality [19]. Therefore, in this study, mixed kasgot with a dose of 150 grams gave the highest growth results in all observation parameters (Figure 4.1) than other kasgot treatments and gave an effect equivalent to urea fertilizer treatment. Increasing the level of fertilizer application and its nutrient content will also increase the availability of nutrients for plants, thus spurring optimal metabolic processes and increasing the number and area of leaves [20].

Figure 4.1. Results of kasgot treatment on pakcoy growth (Personal documents)

The availability of nutrients plays an important role in plant growth, especially in affecting vegetative growth and chlorophyll levels of pakcoy. In this study, treatment K1 (control without treatment) produced the lowest growth results and chlorophyll levels, because the plants did not get an optimal supply of nutrients that inhibited the growth process. Lack of nutrient supply can slow down the activity of cells, thus affecting the metabolic rate of plants and resulting in inhibition of the process of plant growth and development, especially in the formation of new organs such as leaves [21].

Nitrogen originating from kasgot is absorbed by the roots in the form of nitrate and ammonium with the help of transporter proteins located on the root cell membrane [22] and is translocated to leaf organs through xylem vessels and binds to carbohydrates to form proteins [23]. The resulting protein is used as the basic material for the formation of protoplasm and enzymes which then move towards the meristematic region and cause cell division and enlargement. Nitrogen in kasgot also provides an important component for the synthesis of amino acids, which are used as the basis for the formation of protoplasm and enzymes, encourages cell enlargement and division [22]. In addition, it also plays a role in encouraging the process of differentiation in apical and intercalar meristems [24] to encourage primary growth that stimulates the growth process of leaf area, number of leaves, plant height [25].

Nitrogen absorbed by plants is in the form of nitrate and ammonium. Nitrate that is absorbed, undergoes a reduction process involving the enzymes nitrate reductase and nitrite reductase. Nitrate reductase converts nitrate to nitrite (NO_2-), while nitrite reductase further reduces nitrite to ammonium. The resulting ammonium undergoes a complex process of nitrogen assimilation that involves the conversion of ammonium into glutamate, an amino acid that serves as a building block for various proteins and other nitrogenous compounds. Glutamate, a product of ammonium assimilation, is further converted into various amino acids, including tryptophan. Tryptophan has special significance because it acts as a precursor to auxin. Auxin here functions as a growth regulator that accelerates plant height growth [26].

The availability of phosphorus in kasgot is an ingredient in the formation of cell nuclei which has a role in the development of meristematic tissue which encourages cells in pakcoy to actively divide. The higher the cell division activity, the more plant organs are formed [27]. Phosphorus also plays a role in the formation of ATP for photosynthate translocation to plant organs. This increase in cellular activity leads to the production of more plant organs, thus contributing to overall plant growth and biomass accumulation [28].

Potassium absorbed also plays an important role as an activator of various enzymes in photosynthesis and respiration. Potassium also plays a role in carbohydrate accumulation and transport, regulation of stomatal opening and closing, and regulates water distribution in tissues and cells which together play a role in optimizing plant metabolic processes [13].

The results of wet weight in pakcoy have a close relationship with the water content absorbed by pakcoy. High water availability will increase nutrient absorption, trigger division, cell elongation and tissue formation so as to encourage optimal growth of plant height, number of leaves and leaf area and result in an increase in pakcoy wet weight [29].

Nitrogen in kasgot also plays a role in increasing the ratio of protoplasm to cell walls, so that cells become larger with thin cell walls. This causes pakcoy to have more space to store water (Pramushinta & Yulian, 2020). Potassium contained in kasgot plays an important role in the transportation of photosynthates to all parts of the plant, and produces optimal plant weight [29].

The result of dry weight in pakcoy is influenced by the availability of nutrient supply from kasgot. Dry weight can increase due to the absorption of CO_2 during photosynthesis, and will decrease due to the release of CO_2 during the respiration process. The balance of these two processes determines the dry weight which is influenced by the nutrient uptake of kasgot [30].

In general, the results of this pakcoy research show that the higher the dose of kasgot fertilizer results in higher pakcoy dry weight. This is because the higher the dose of kasgot, the higher the supply of nutrients for plants [31].

The nitrogen nutrient content in kasgot absorbed by pakcoy plays an important role in the total dry weight of pakcoy. The nitrogen absorbed will support various physiological processes in pakcoy, including photosynthesis, protein and amino acid synthesis, and cell division. Through transcription and translation, these amino acids are assembled into proteins. These proteins serve as functional or structural proteins for biomass formation and crop yield. Nitrate reductase activity has a positive correlation with production, dry weight, total nitrogen and plant yield [32].

Chlorophyll levels of pakcoy formed have differences between treatments with one another. The difference in chlorophyll content in each plant will affect the difference in the ability to absorb light intensity and certain wavelengths based on the pigments it has [33]. The chlorophyll content in each treatment increased according to the dose of kasgot given, this is because the formation of chlorophyll requires nutrients. Optimal availability of megnesiun and nitrogen will cause optimal chlorophyll formation [18].

The main components that make up this chlorophyll are nitrogen and magnesium. Magnesium in kasgot absorbed by plants in the form of Mg2+ ions [34] acts as a constituent of chlorophyll molecules together with nitrogen to form porphyrin rings in the thylakoid membrane for photosynthesis [35]. Magnesium is the core molecule in chlorophyll located in chloroplasts and plays an important role in chlorophyll formation. Chlorophyll is a catalyst in photosynthesis located in the thylakoid membrane as a green pigment for photosynthesis loosely bound to proteins. Optimal magnesium availability will increase the greenness of the leaves which has an impact on increasing photosynthate yields used for cell formation energy and stored in the form of carbohydrate derivatives [36].

Nitrogen in kasgot absorbed by pakcoy will be used as the main ingredient for chlorophyll, therefore the availability of chlorophyll is directly proportional to the nitrogen nutrients provided. Nitrogen kasgot available in the planting media can be absorbed by plant roots in the form of nitrate and ammonium ions. Both forms of nitrogen come from the decomposition of organic matter. Nitrate that is absorbed by the roots is absorbed and transported to the leaves through the xylem vessels to the leaves of the plant through the transpiration process. Nitrogen absorbed by plants will occur nitrite to nitrate reaction that occurs in green leaves, namely in chloroplasts [36].

Plants will absorb nitrogen in the form of ammonia and then ammonia changes into glutamic acid, catalyzed by the enzyme glutamine synthetase. Glutamic acid is important for the formation of nucleic acids and amino acids. Glutamic acid will form aminolevulinic acid (ALA) which acts as a precursor to the porphyrin ring for chlorophyll formation. Therefore, plants that get high nitrogen supply will produce wider leaves with more intense green color due to high chlorophyll content [37].

5. CONCLUSION

Kasgot organic fertilizer has a significant effect on pakcoy growth (number of leaves, leaf area, plant height, wet and dry weight) and pakcoy chlorophyll levels. The best kasgot fertilizer is found in the A2 treatment (150 grams of mixed kasgot). The higher the dose given, the higher the chlorophyll content formed

6. REFERENCES

1. [1] Suprapti, I., Wulandari, S. E., Agustina, N. W., Putri, M. D., Arifin, A., Toha, E., & Romadhoni, A. H. (2023). Application of Innovation Technology for Making Biosaka Fertilizer in Ellak Laok Village, Lenteng District, Sumenep Regency. *Pangabdhi Scientific Journal*, *9*(1), 16-21.
2. [2] Agustin, H., & Musadik, I. M. (2023). Nutrient content of black soldier fly (hermetia illucensi) larval cassava as organic fertilizer. *Indonesian Journal of Agricultural Sciences*, *25*(1), 12-18.
3. [3] Muliani, I. & Agustin, H. (2021). Effectiveness of Kasgot as a planting medium on Kailan production. *Agrin Journal*, *25*(2), 150-164.
4. [4] Ambarningrum, T. B., K., E. S., & Basuki, E. (2019). Bioconversion Technology of Household Organic Waste Using Black Soldier Fly Larvae. *Proceedings: Sustainable Development of Rural Resources and Local Wisdom IX*, *1*, 235-243.
5. [5] Nuryana, F. I., Ikrarwati, Rokhmah, N. A., Aldama, F. and, & Nabila. (2022). Kasgot as Organic Material for Leaf Vegetable Seedlings. *Proceedings of the National Seminar on Agribusiness Research Results VI*, 6(1), 235-240.
6. [6] Nirmala, W., Purwaningrum, P., & Indrawati, D. (2020). Effect of Market Waste Composition on Organic Compost Quality with the Black Soldier Fly (Bsf) Larva Method. *Proceedings of the National Expert Seminar*, 1-5.
7. [7] Edyson, Indawan, Ricky I. H., Hidayati K., and P. I. H. (2023). Black soldier fly cassava as organic fertilizer for sustainable agriculture. *Agrika: Journal of Agricultural Sciences*, *17*, 156-168.
8. [8] Fauzi, M., M, L. H., Suhada R, Q. A., & Hernahadini, N. (2022). Effect of Maggotsuka Fertilizer on Height, Number of Leaves, Leaf Surface Area and Wet Weight of Green Mustard Plants (*Brassica rapa*). *Agritrop: Journal of Agricultural Science*, *20*(1), 20-30.
9. [9] Purwanto, Kharisun, Ismngil, Ruly Eko K. Kurniawan, R. N. (2023). Effect of kasgot organic fertilizer dose on agronomic characters and yield of spinach (Amaranthus tricolor). *Agro Journal*, *10* (1), 83-97.
10. [10] Arimurti, F., & Nur, H. (2023). Effect of Storage Technique on Quality of Pakcoy (*Brassica rapa* L) and Pakcoy

Concentration on Physical and Sensory Properties of Hot Juice (Pineapple Pakcoy). *Journal of Multi Discipline*, *2*(2), 277-286.

11. [11] Pratama, M. K. N., & Setiawan, G. (2021). Design of Soil Moisture Control System for Pakcoy and Mustard Vegetable Farm. *Journal of Automation Control and Instrumentation*, *13*(2), 101-108
12. [12] D. Altshuler, J.N. Hirschhorn, M. Klannemark, C.M. Lindgren, M.-C. Vohl, J. Nemesh, et al., The common PPARγ Pro12Ala polymorphism is associated with decreased risk of type 2 diabetes, Nat. Genet. 26 (2000) 76-80.
13. [13] Nurhasanah, S., Komariah, A., Hadi, R. A., & Indriana, K. R. (2021). Growth response and yield of pakcoy (*Brassica rapa* L.) flamingo variety due to the treatment of planting media and concentration of bayfolan liquid complementary fertilizer. *Journal of Research Innovation*, 2(3), 949-954.
14. [14] Kare, B. D. Y., Sukerta, M., Javandira, C., & Ananda, K. D. (2023). The Effect of Kasgot Fertilizer on the Growth and Yield of Pakcoy Mustard Plants (*Brassica rapa* L.). *Agrimeta: Journal of Agriculture Based on Ecosystem Balance*, *13*(25), 59-66.
15. [15] Upe, A. & Santoso, A. A (2020). Effect of Planting System on Growth and Production of Mustard Plants (*Brassica Juncea* L.). *Agrotani Scientific Journal*, *2*(1), 27-32.
16. [16] Gogahu, Y., Nio, S. A., & Siahaan, P. (2016). Chlorophyll concentration in some varieties of Puring (Codiaeum varigatum L.) plants. *Journal of Mipa*, *5*(2), 76-80.
17. [17] Setyanti, Y. H., Anwar, S., & Slamet, W. (2013). Photosynthetic characteristics and phosphorus uptake of alfalfa (Medicago sativa) forage at different cutting height and nitrogen fertilization. *Animal Agriculture Journal*, 2(1), 86-96.
18. [18] Bungard, R. A., Zipperlen, S. A., Press, M. C., & Scholes, J. D. (2002). The influence of nutrients on growth and photosynthesis of seedlings of two rainforest dipterocarp species. *Functional Plant Biology*, *29*(4), 505-515.
19. [19] [Yama, D. I., & Kartiko, H. (2020). Growth and Chlorophyll Content of Pakcoy (*Brassica rapa* L) at Several Concentrations of AB Mix with Wick System. *Journal of Technology*, *12*(1), 21-30.
20. [20] Rokhmah, laela N., Setiawan, Ryan B., Purba, Deasy H., Anggraeni, N., Suhendriani, S., Faridi, A., Widhi H., M., Kristianto, Y., Hasanah, Laeli N., Argaheni, Niken bayu, Anto, Handayani, T., & Rasmaniar. (2022). *Full Book Food and Nutrition*. Yayasan Kita Tulis.
21. [21] Vivonda, T., & Yoseva, S. (2016). Optimizing the Growth and Production of Pakcoy (Brassicca Rapal) Plants Through the Application of Several Doses of Bokashi Fertilizer, *JOM Faperta*, *3*(2), 1.
22. [22] Marajahan, Y., Khoiri, A., Agrotechnology, J., Agriculture, F., & Riau, U. (2010). Application of NPK Fertilizer on the Growth of Cocoa (Theobroma Cacao L.) Planted between Oil Palm. *Journal of Agrotechnology*, *2*(1), 1-9.
23. [23] Krisdianto, A., Saptiningsih, E., Nurchayati, Y., & Setiari, N. (2020). Growth of Phalaenopsis amabilis (L.) Blume Orchid Plantlets at Subculture Stage with Different Media Type and Peptone Concentration Treatments. *Metamorphosa: Journal of Biological Sciences*, *7*(2), 40.
24. [24] Hartini, Sri, Siti M. S., and E. M. (2019). Effect of Rabbit Urine Concentration on Growth and Yield of Red Spinach (Amaranthus gangeticus voss) Sri. *ITS Journal of Science and Arts*, *10*(1), 20-27.
25. [25] Widiastoety, D. (2016). Effect of Auxin and Cytokinin on the Growth of Mokara Orchid Planlets. *Journal of Horticulture*, *24*(3), 230.
26. [26] Dhani, Herry, Wardati, R.

(2017). Effect of Vermicompost Fertilizer on Inceptisol Soil on Growth and Yield of Green Mustard (*Brassica juncea* L). *Экономика Региона*, 32.

27. [27] Fu, Y. F., Yang, X. Y., Zhang, Z. W., & Yuan, S. (2022). Synergistic effects of nitrogen metabolites on auxin regulating plant growth and development. *Frontiers in Plant Science*, *13*, 1098787.
28. [28] Wenno, S. J., & Sinay, H. (2019). Chlorophyll Content of Pakcoy Leaves After Manure and Tofu Dregs Treatment as Teaching Materials for Plant Physiology Course. *Biopendix: Journal of Biology, Education and Applied*, 5(2), 130-139.
29. [29] Anjani, B. P. T., Bambang Budi Santoso, & Sumarjan. (2022). Growth and Yield of Pakcoy Mustard (*Brassica rapa* L.) Container Planting System at Various Doses of Vinegar Fertilizer. *Scientific Journal of Agrocomplex Students*, *1*(1), 1-9.
30. [30] Putri, F. M., Suedy, S. W. A., & Darmanti, S. (2017). Effect of Nanosilica Fertilizer on the Number of Stomata, Chlorophyll Content and Growth of Black Rice (Oryza sativa L. cv japonica). *Bulletin of Anatomy and Physiology*, *2*(1), 72-79.
31. [31] Sinaga, W. S., Limeranto, D. M., Pangala, E. L. B., & Madyaningrana, K. (2023). Effects of Fruit Peel-Based Liquid Organic Fertilizer (Eco Enzyme) on the Growth of Pakcoy (*Brassica chinensis* L.) Plants. *Pro-Life*, *10*(2), 839-852.
32. [32] Hidayat, Y. V., Enggar A., S. S. (2020). Community perceptions of the new rice field printing program in Air Kering Village, Padang Guci Hilir District, Kaur Regency and its influence on the environment. *Journal of Natural Resources and Environmental Management Research*, 9(1), 41-54.
33. [33] Fitriana, J., Pukan, K. K., & Herlina, L. (2011). Nitrate Reductase Enzyme Activity of Soybean Cultivar Burangrang due to Variation of Soil Water Content at the Beginning of Pod Filling. *Bioscience: Journal of Biology & Biology Education*, *1*(1).
34. [34] Dini, P. S. R., Susanto, A. B., & Pramesti, R. (2021). Effect of Liquid Fertilizer Concentration on Growth and Chlorophyll-a Content of Gracilaria verrucosa (Harvey) Seaweed. *Journal of Marine Research*, *10*(3), 327-332.
35. [35] Damanhuri, D., Widodo, T. W., & Fauzi, A. (2022). Regulation of Nitrogen and Magnesium Balance to Improve Corn (Zea Mays L.) Growth and Production. *Scientific Journal of Innovation*, *22*(1), 10-15.
36. [36] Wirawan, B. D. S., Putra, E. T. S., & Yudono, P. (2016). Effect of Magnesium, Boron and Silicon on Physiological Activity, Fruit Tissue Structural Strength and Yield of Banana (Musa acuminata) "Raja Bulu." *Vegetalika*, 5(4), 1-14.
37. [37] Suharja, & Sutarno. (2009). Biomass, chlorophyll content and leaf nitrogen of two varieties of chili (Capsicum annum) in various fertilizer treatments. *Nusantara Bioscience*, *1*, 9-16.
38. [38] Rosyida, R., & Nugroho, A. S. (2017). Effect of compound npk fertilizer doses and pgpr (plant growth promoting rhizobacteria) on wet weight and leaf chlorophyll content of pakcoy (*Brassica rapa* L.) plants. *Bioma: Scientific Journal of Biology*, 6(2), 42-56.
39. [39] Kusnia, C. A., Taryana, Y., & Turmuktini, T. (2022). Pengaruh Dosis Pupuk Organik Urin Kelinci Terhadap Pertumbuhan Dan Hasil Tanaman Pakcoy (Brassica Rapa L.) Varietas Nauli F1. *OrchidAgro*, *2*(1), 24-30.