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Effectiveness of Rice Water and Clam Shells on Red Chili Plants (*Capsicum annuum* L.) Growth

Efektivitas Cucian Beras dan Cangkang Kerang terhadap Pertumbuhan Tanaman Cabai Merah (Capsicum annuum L.)

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Abstract. Red chili (*Capsicum annuum* L.) are vegetables frequently used in cooking. However, their supply often falls short of market demand. Inorganic fertilizers are commonly used to enhance plant productivity, but their excessive use can damage soil and agricultural ecosystems, and they are relatively expensive. This study aims to evaluate the effectiveness of rice water and clam shells on the growth of red chili, including plant height, number of leaves, and stem diameter. This aligns with the SDGs' goals of zero hunger and responsible consumption and production by utilizing waste as fertilizer to boost plant growth. The research design employed a Randomized Block Design with treatment of rice water and clam shells concentrations at 0%, 10%, 20%, 40%, 60%, and 80%, along with NPK + ZA fertilizer, with four replications. The data obtained were analysed using one-way ANOVA, and Duncan's test was to compare means between treatments. The results indicated that the application of rice water and clam shells at different concentrations, as well as NPK + ZA fertilizer, significantly affects plant height but does not impact the number of leaves or stem diameter. The optimal treatment was found to be 80% concentration of liquid organic fertilizer.
Keywords: red chili; liquid organic fertilizer; rice water; clam shells; waste

Abstrak. *Cabai merah (Capsicum annuum L.) merupakan sayuran yang sering dimanfaatkan sebagai bahan masakan. Namun, suplai cabai yang tersedia belum dapat mencukupi kebutuhan pasar. Pupuk anorganik lazim digunakan dalam meningkatkan produktivitas tanaman. Namun, penggunaannya secara berlebihan dapat merusak tanah serta ekosistem pertanian dan harganya juga relatif mahal. Penelitian ini bertujuan untuk menentukan efektivitas POC cucian beras dan cangkang kerang terhadap pertumbuhan tanaman cabai merah meliputi tinggi tanaman, jumlah daun dan diameter batang, sehingga selaras dengan upaya perwujudan SDGs yakni menghilangkan kelaparan serta konsumsi dan produksi yang bertanggung jawab melalui pemanfaatan limbah sebagai pupuk guna meningkatkan pertumbuhan tanaman. Rancangan penelitian menggunakan Rancangan Acak Kelompok (RAK) dengan satu perlakuan, yakni konsentrasi POC cucian beras dan cangkang kerang meliputi 0%, 10%, 20%, 40%, 60%, 80%, serta pupuk NPK + ZA dengan empat kali pengulangan. Data yang didapat dianalisis dengan metode Anova satu arah dan untuk membandingkan rata-rata antar perlakuan dilakukan uji Duncan. Hasil penelitian menyatakan bahwa terdapat pengaruh dari pemberian POC cucian beras dan cangkang kerang dengan konsentrasi yang berbeda serta pupuk NPK + ZA pada tinggi tanaman, tapi tidak berpengaruh pada jumlah daun dan diameter batang tanaman. Perlakuan optimal ditunjukkan oleh POC dengan konsentrasi 80%.*
Kata kunci: *cabai merah; pupuk organik cair; cucian beras; cangkang kerrang; limbah*

INTRODUCTION

Chili are a popular horticultural commodity within the vegetable category, especially favored in household settings. They are highly nutritious, containing 7.3 g of carbohydrates, 0.3 g of fat, 1.0 g of protein, 29 mg of calcium, 0.05 mg of vitamin B1, 18 mg of vitamin C, as well as iron, phosphorus, and alkaloid compounds such as capsaicin (Sepwanti *et al.*, 2016). The high human demand and rapid technological advancements have led to various uses for chili, including their application as a spice, coloring agent, medicine, beauty product, and other uses. Red chili can also be used as a preservative for food products, addressing issues such as nutrient loss, rancidity, changes in odor and color, and alterations in texture in processed foods (Anoviansyah *et al.*, 2018).

Data from the Central Statistics Agency (BPS) (2021) and (2022) shows an increase in the total harvested area of red chili in Indonesia from 2019 to 2021. The harvested area for red chili in 2019, 2020, and 2021 was 133,434 ha, 133,729 ha, and 141,986 ha, respectively. Additionally, the production of red chili also rose from 2019 to 2021. The harvest yields for red chili in 2019, 2020, and 2021 were 1,214,418 tons, 1,264,190 tons, and 1,358,201 tons, respectively. Despite this, the available chili supply has not been sufficient to meet market demand. This is evidenced by the fluctuating prices of chili. When supply and demand are balanced, prices remain stable. However, when supply decreases, chili prices soar (Prihandana *et al.*, 2024). According to Nauly (2016), the fluctuations in chili prices are caused by the seasonal nature of chili cultivation, weather factors, input costs, and the lengthy marketing channels resulting from disparities in chili supply distribution across different regions.

Increasing the productivity of red chili plants remains essential to stabilize their prices. To enhance productivity, inorganic fertilizers are commonly used in agriculture. Farmers today continue to use inorganic fertilizers on their crops because they provide nutrients quickly, but this increases production costs. Inorganic fertilizers are made from synthetic materials, and excessive use can render the soil toxic (Khandaker *et al.*, 2017). This has led many researchers to explore the use of organic materials as fertilizers. One such option is organic fertilizer made from rice water.

Rice water contains 0.015% nitrogen, 16.306% phosphorus, 0.02% potassium, 14.252% magnesium, 2.944% calcium, 0.0427% iron, 0.027% sulfur, and 0.043% thiamine (vitamin B1) (Lalla, 2018). According to research by Cahyono *et al.* (2022), applying rice water fertilizer at concentrations of 0.10 l/l water, 0.20 l/l water, and 0.30 l/l water to bitter melon (*Momordica charantia* L.) showed that the fertilizer influenced the weight and length of the fruit as well as the wet and dry weight of the plant's biomass, with the most effective concentration being 0.30 l/l water.

Nutrient elements can also be provided to plants through the application of clam shells shell-based fertilizers. Saputra *et al.* (2018) reported that Indonesia produced 48,994 tons of blood cockles, making it the top producer of cockles in Southeast Asia in 2012. The abundance of blood cockle shells, which accounted for 75.7% to 77.3% of the total, results from this high production. Additionally, the surplus and neglected blood cockle shells can lead to environmental pollution that harms humans. According to research by Umami and Suprijanto (2013) at the Central Java Industrial Pollution Control Technology Center (BBTPPI), blood cockle shells contain 0.54% fat, 4.12% protein, 0.66% carbohydrates, 0.66% nitrogen, 0.21% phosphorus, 0.09% potassium, 91.82% ash, and 21.37% calcium. Based on the study by Fazrina and Yursilla (2019), applying 50% of the cockle shell liquid organic fertilizer (*Anadara granosa*) resulted in the best outcomes for plant height, leaf number, leaf width, and wet weight of mustard greens.

The N, P, and K content in organic fertilizers is essential for plant growth. Nitrogen functions as a component of protein formation, promotes plant shoot growth, and enhances vegetable development. Phosphorus acts as a protein-building component, is necessary for the formation of flowers, fruits, and seeds, and stimulates root elongation and strengthening, helping plants withstand drought conditions. Insufficient phosphorus can result in stunted and small plants, wilting, easy collapse, and delayed seed and flower formation. Potassium plays a role in metabolic processes, including respiration and photosynthesis (Fazrina and Yursilla, 2019).

Given this information, the purpose of this research is to examine the effects of different concentrations of organic liquid fertilizers from rice water and blood cockle shells, as well as NPK + ZA fertilizers, on the growth of red chili (*Capsicum annuum* L.). This study aims to contribute to achieving Sustainable Development Goals (SDGs) such as zero hunger and responsible consumption and production by utilizing waste as fertilizer to enhance plant productivity.

MATERIALS AND METHODS

This research was conducted from February to June 2024. The study was divided into two phases. Phase I involved the preparation of liquid organic fertilizers from rice water and blood cockle shells (*Anadara granosa*). The production of these fertilizers took place in Cangkring Gatak Hill, Seduri Village, Balongbendo District, Sidoarjo. Phase II consisted of testing the macro-nutrient levels (N, P, K, organic C, and C/N ratio) and micro-nutrient (Fe) content of the liquid organic fertilizers at the Soil Resource Laboratory, Study Program of Agrotechnology, Faculty of Agriculture, National Development University "Veteran" of East Java.

The first step was growing media preparation, which consisted of a combination of soil, goat manure, and rice husk charcoal in a 1:1:1 ratio (Gustia and Rosdiana, 2019). This mixture is sterilized using Basamid 98 GR (Mardiah *et al.*, 2016). Next, red chili seeds, which had been soaked in water at 50°C for 3 hours, were sown in seed trays until they reach 30 days after sowing (HSS). The seedlings were then transferred from the seed trays to polybags containing the growing medium, with one polybag accommodating one chili plant.

The preparation of the liquid organic fertilizer (POC) started with rice water production. The rice water was made by mixing rice and water in a 1:1 ratio, then filtered to remove any remaining rice, husks, or debris. The first rinse water was used as the base for making the POC. Next, the preparation of blood cockle shell flour was carried out. The shells were cleaned with water, air-dried, and then oven-dried at 110°C for 1 hour. The shells were ground into a powder using a mortar and pestle. To make the POC, 320 grams of cockle shell powder were mixed with 1.6 liters of rice water, 80 ml of EM4, and 160 grams of sugar. This mixture was stirred until the sugar dissolves and then transferred to plastic bottles. The fertilizer was fermented anaerobically for 28 days.

The application of the liquid organic fertilizer (POC) followed specific concentrations: POC 0% (100 ml water), POC 10% (10 ml POC + 90 ml water), POC 20% (20 ml POC + 80 ml water), POC 40% (40 ml POC + 60 ml water), POC 60% (60 ml POC + 40 ml water), and POC 80% (80 ml POC + 20 ml water). The POC was applied once a week in the morning at a volume of 100 ml per plant (Arbani *et al.*, 2018). Inorganic fertilizers, NPK 15-15-15 and ZA, were applied by watering the base of each plant at 0 and 2 months after planting. The fertilizer dosage consisted of 20 grams of NPK 15-15-15 and 5 grams of ZA dissolved in 2 liters of water. This solution was applied at a rate of 100 ml per plant (Nurbaiti and Firdaus, 2016). Maintenance included watering, staking, pruning, and pest and disease control.

Growth parameter observed including measuring the plant height from the surface of the growing medium to the plant's growing point, counting the number of fully expanded leaves, and measuring the stem diameter using a caliper at the base of the plant when the plants are 15, 30, and 45 days after sowing (HSS). Growth data, including plant height, leaf number, and stem diameter, was analysed using one-way ANOVA followed by Duncan's multiple range test if the treatment effects were significant (Tangoi *et al.*, 2019).

RESULT

The results of phase I provide data on the quality of the liquid organic fertilizer (POC) made from rice water and blood cockle shells, based on macro-nutrient content (N, P, K, and organic C) and micro-nutrient content (Fe). These results are presented in Table 1.

Table 1. Nutrient content of liquid organic fertilizer (POC)

No.	Parameter	Nutrient Content	Category
1.	C/N Ratio (%)	27,8	Very High
2.	Organic Carbon (%)	2,5	Medium
3.	Nitrogen (%)	0,09	Very Low
4.	Phosphorus (ppm)	359	Very High
5.	Potassium (ppm)	412	Very High
6.	Iron (ppm)	10	Medium
7.	pH	6,16	Slightly Acidic

Table 1 shows that the C/N ratio was 27.8% (very high); organic carbon 2.5% (medium); nitrogen 0.09% (very low); phosphorus 359 ppm (very high); potassium 412 ppm (very high); iron 10 ppm (medium); and pH was 6.16 (slightly acidic). Based on these results, the POC from rice water and blood cockle shells was indicated to not meet the standards in terms of the nutrient content.

This study observed growth parameters including plant height, number of leaves, and stem diameter. The effects of applying POC from rice water and blood cockle shells, as well as NPK + ZA fertilizers, on these growth parameters are presented in Table 2.

The data analysis indicated that the application of various concentrations of liquid organic fertilizer from rice water and blood cockle shells, as well as NPK + ZA fertilizer, had a significant effect on the height of red chili pepper plants. However, it did not significantly affect the number of leaves and stem diameter, so Duncan's test was not performed for these parameters. The treatment with POC at 80% concentration showed the best results across all three growth parameters, with an average plant height of 117.025 cm, a leaf count of 262 leaves, and a stem diameter of 8.88 mm.

Table 2. Plant height, number of leaves, and stem diameter of red chili peppers after application of various concentrations of POC from rice water and blood cockle shells

Treatment	Plant Height* (cm)	Number of Leaves (pieces)	Stem Diameter (mm)
POC 0% (100 ml water)	102,525 ± 0,74[a]	178,50 ± 57,2	8,05 ± 0,66
POC 10% (10 ml POC + 90 ml water)	105,400 ± 6,49[ab]	216,50 ± 47,13	8,20 ± 0,98
POC 20% (20 ml POC + 80 ml water)	109,150 ± 1,99[bc]	226,25 ± 15,65	8,45 ± 0,48
POC 40% (40 ml POC + 60 ml water)	110, 375± 4,82[bc]	240,25 ± 48,40	8,65 ± 1,29
POC 60% (60 ml POC + 40 ml water)	113,325 ± 3,78[cd]	261,00 ± 57,74	8,78 ± 0,21
POC 80% (80 ml POC + 20 ml water)	117,025 ± 2,45[d]	262,00 ± 106,97	8,88 ± 0,83
Inorganic Fertilizer (NPK +ZA)	108,125 ± 3,76[abc]	225,50 ± 67,44	8,40 ± 0,62

Note: *)Values followed by different letters in the same row are significantly different according to Duncan's test at 5% level.

DISCUSSION

The quality of a liquid organic fertilizer can be assessed based on its macro-nutrient values (NPK), organic C, and C/N ratio, as well as micro-nutrient content (Fe). The POC from rice water and blood cockle shells had the following nutrient values: C/N ratio of 27.8% (very high); organic carbon of 2.5% (medium); nitrogen of 0.09% (very low); phosphorus of 359 ppm (very high); potassium of 412 ppm (very high); iron of 10 ppm (medium); and a pH of 6.16 (slightly acidic). According to the Indonesian Minister of Agriculture's Decree No. 261/KTPS/SR.310/M/4/2019 regarding Minimum Technical Requirements for Organic Fertilizers, Bio-Fertilizers, and Soil Amendments, the organic carbon content of 2.5% is below the minimum standard of 10%. The combined N + P_2O_5 + K_2O content of 0.1671% was below the standard range of 2-6%. The Fe content of 10 ppm was below the standard range of 90-900 ppm. However, the pH of 6.16 met the standard range of 4-9 (Keputusan Menteri Pertanian Republik Indonesia, 2019). Based on these analyses, the POC from rice water and blood cockle shells does not meet the required nutrient standards.

The organic carbon concentration in the fertilizer product was 2.5%, which is considered medium. Organic carbon in raw materials serves as an energy source for microbial metabolism. This chemical transformation of organic materials into specific enzymes by microbes is known as decomposition or fermentation (Prasetyo and Evizal, 2021).

Carbon is broken down by microorganisms, leading to the production of ammonia and nitrogen (Rahmawati *et al.*, 2020). As fermentation continues over time, the amount of organic carbon decreases while nitrogen content increases. In this study, the fermentation process lasted only 28 days. This limited fermentation time resulted in a nitrogen concentration of 0.09% in the organic fertilizer, which was very low, and consequently, a C/N ratio of 27.8%, which was very high. Thus, it can be concluded that the POC still requires more time for fermentation to achieve optimal nutrient content.

The C/N ratio can be used as a parameter to determine the maturity of fertilizer. If the ratio of carbon to nitrogen falls within the range of 20% to 30%, it indicates that the fertilizer is ready for application (Pandi *et al.*, 2023). Another factor contributing to the low nitrogen content is that the POC was not supplemented with plant-based materials that could enhance the nitrogen content. To increase the nitrogen level in POC, it is advisable to include plant residues, particularly from legume families or weeds, in the production mix (Rafidah *et al.*, 2023). Legumes can fix atmospheric N_2 through a symbiotic relationship with bacteria in root nodules (Tegeder and Masclaux-Daubresse, 2018). Other plants, such as *Azolla microphylla*, an aquatic fern species known for its high biomass production and rich nitrogen content, could also be considered for inclusion (Rafidah *et al.*, 2023).

The analysis revealed that the phosphorus (P) content was 359 ppm, which is considered very high. Fermentation influences the phosphorus content, but an increased fermentation time does not necessarily lead to a higher phosphorus concentration. This is because fermentation is associated with microorganisms that go through a stationary phase. During this phase, microorganisms grow rapidly, but as fermentation continues, they eventually die off, resulting in a lower phosphorus concentration than initially observed (Putra and Ratnawati, 2019). Similarly, the potassium (K) content was found to be 412 ppm, which is also considered very high. The high potassium content is due to the formation of organic acids during the decomposition process, which enhances the solubility of nutrients such as phosphorus, potassium, and calcium. As a result, the potassium available for plants is increased (Tallo and Sio, 2019).

Plants require micronutrients in very small amounts, typically measured in ppm relative to the dry weight of the plant (Kasmawan *et al.*, 2018). One essential micronutrient for plants is iron (Fe). The iron concentration in the organic fertilizer is 10 ppm, which is considered medium. Iron is crucial for several plant processes, including redox reactions in photosynthesis and respiration, bacterial fixation in root nodules, and nitrate reduction (Rahayu *et al.*, 2023).

Microbial activity in decomposing organic matter is influenced by the pH level. An unsuitable pH can affect the absorption of nutrients by plants. The POC from rice water and blood cockle shells has a pH of 6.16, which is considered slightly acidic. Acidic pH levels are suitable for the growth of decomposing microorganisms involved in organic matter breakdown. Conversely, excessively alkaline conditions can increase oxygen consumption and have negative environmental consequences, while overly acidic conditions can lead to the death of some microorganisms (Rafidah *et al.*, 2023). The results obtained for the POC from rice water and blood cockle shells meet the established standards.

This study examined the effects of different concentrations of POC from rice water and blood cockle shells, as well as NPK + ZA fertilizer, on the vegetative growth of plants, including plant height, number of leaves, and stem diameter (Table 2). The analysis revealed that the application of various concentrations of POC and NPK + ZA significantly affected the height of red chili plants. This effect is attributed to the ability of liquid organic fertilizers to improve soil structure by enhancing soil particle aggregation. Organic materials act as binders, aiding in the formation of larger soil aggregates. A well-structured soil allows for better water flow, root penetration, and air circulation within the soil. Organic fertilizers also improve the soil's water-holding capacity. Organic matter can absorb and retain water more effectively than soil with lower organic content. This helps reduce water loss through evaporation and optimizes water availability for plants (Siregar, 2023). With improved soil structure and water retention, plant growth can occur more optimally.

The composition of raw materials in organic fertilizers is one of many influencing factors. Rice water contains nutrients, carbohydrates, vitamins, and other minerals. Carbohydrates in rice water play a role in bridging the formation of gibberellin and auxin hormones, which are commonly used in synthetic plant growth regulators (ZPT). Auxin and gibberellin can work together to elongate stems. Auxin stimulates shoot growth and the formation of new buds, while gibberellin acts as a root stimulant (Nurlia *et al.*, 2022). When underground growth is optimal, above-ground plant growth will also be vigorous because the roots can effectively utilize the necessary nutrients.

The height of red chili plants is also influenced by the presence of vitamin B1 in rice water. Kholifah and Suparti (2022) have highlighted that vitamin B1 supports smooth metabolic processes in plant tissues by converting carbohydrates into energy, preventing stress from exposed roots or environmental adjustments, and maintaining plant condition to prevent wilting through optimal nutrient absorption from the soil. Additionally, vitamin B1 is necessary for plant growth processes, such as stimulating cell division and enhancing the growth rate of new tissues.

Furthermore, Hasmeda *et al.* (2021) noted that iron (Fe) can contribute to increased plant height, leaf area, dry weight, and enhance both iron content and chlorophyll levels in plants. Although Fe is not a component of the chlorophyll molecule itself, its availability affects chlorophyll content because Fe is required for the formation of the ultrastructure of chloroplasts.

The application of various concentrations of rice water and blood clam shell liquid organic fertilizer, as well as NPK + ZA fertilizers, did not show a significant effect on the number of leaves and stem diameter of the red chili plants. One environmental factor that can affect the number of leaves is the presence of plant pests (OPT), which can influence the leaf count in red chili plants (Walida *et al.*, 2019). Some red chili plants in this study were affected by whiteflies (*Bemisia tabaci*).

Whiteflies are vectors for geminivirus. Typical symptoms include upward curling, wrinkling, and reduction in leaf size. Severely affected plants become stunted and fail to produce fruit. Additionally, whiteflies excrete honeydew, which fosters sooty mold growth, thereby inhibiting physiological processes and causing irregular fruit ripening. Whiteflies reproduce by laying white eggs, usually in circular clusters on the underside of leaves, and these eggs are anchored by a pedicel inserted into a fine slit made by the female in the leaf tissue (Jeevanandham *et al.*, 2018).

Symptoms of the gemini virus were observed when the plants were 24 days after planting. Whitefly control was managed by applying Movento 240SC pesticide, which contains the active ingredients Imidacloprid and Spirotetramat. For preventive purposes, the pesticide was applied at a concentration of 1 ml/liter, while a concentration of 2 ml/liter was used for curative purposes. The pesticide was sprayed on both the upper and lower surfaces of the plant leaves once a week in the morning for a total of 6 applications. The use of Movento 240SC pesticide was effective in controlling the whitefly population and repairing damaged leaf tissues.

Faizal and Ariefin (2022) stated that the products of photosynthesis are primarily used for vertical growth, such as the height of the plant, rather than for increasing stem diameter. This is because active growth in plants tends to be directed upwards, especially at the plant's apex, which results in an increase in height occurring more rapidly than an increase in stem diameter.

Nevertheless, the number of leaves and stem diameter of the red chili plants were observed to increase with higher concentrations of liquid organic fertilizer. This is attributed to the microorganisms in the rice water and blood clam shell liquid organic fertilizer, which continue the decomposition process in the soil, providing a steady supply of nutrients for the plants. The very high C/N ratio in the POC indicates that the fermentation process is not yet complete. It is predicted that the rice water and blood clam shell POC will continue their fermentation process in the soil after application.

Amir *et al.* (2012) reinforced this by noting that the decomposition process of Azolla compost will continue in the soil, thereby providing a sustained supply of nutrients to the soil and plants. In the production of liquid organic fertilizer (POC) from rice water and blood clam shells, EM4 was used as an activator to accelerate the fermentation process. EM4 contains a variety of microorganisms, including photosynthetic bacteria (e.g., *Rhodopseudomonas* sp.), lactic acid bacteria (*Lactobacillus*), *Streptomycetes* spp., actinomycetes, and yeast. Additionally, EM4 includes nitrogen-fixing bacteria and phosphorus-solubilizing bacteria (Munazar *et al.*, 2022).

Photosynthetic bacteria (*Rhodopseudomonas* sp.) use organic matter, plant secretions, and harmful gases, with the help of sunlight and geothermal heat, as energy sources to produce substances such as amino acids, nucleic acids, bioactive compounds, and sugars. These substances play a crucial role in accelerating plant growth. Lactic acid bacteria (*Lactobacillus*) inhibit the growth of harmful microorganisms, break down lignin and cellulose to be fermented without producing toxic compounds, and enhance the rate of organic matter decomposition. During fermentation, yeast produces compounds necessary for plant growth, including bioactive substances (hormones and enzymes) that support root development. Yeast secretions also serve as a substrate for lactic acid bacteria and *Actinomycetes*. *Actinomycetes* work alongside photosynthetic bacteria. EM4 also contains fermentation fungi that help reduce unpleasant odors, prevent insect and caterpillar infestations, and decompose complex compounds into esters, alcohols, and antimicrobial substances (Sari & Alfianita, 2018).

Nitrogen-fixing bacteria are capable of converting atmospheric N into ammonia for their host plants through the formation of nodules on the roots or stems (Igiehon and Babalola, 2018). Phosphate-solubilizing bacteria can dissolve fixed P by releasing organic acids, which lower the pH, through chelation activity, competing with P for adsorption sites, and by releasing P through the formation of soluble complexes with metal ions that otherwise strongly bind P (Billah *et al.*, 2019).

Additionally, the nutrient content of the growing media, which is a mixture of soil, manure, and rice husk charcoal in a 1:1:1 ratio, meets the standards for plant growth, resulting in favorable increases in both leaf number and stem diameter. The 80% concentration of the rice water and blood clam shell liquid organic fertilizer demonstrates the most beneficial effect on plant growth parameters, including plant height, leaf number, and stem diameter, with an average plant height of 117.025 cm, 262 leaves, and a stem diameter of 8.88 mm.

Based on the vegetative growth parameters observed, the results show that the plant measurements with a 20% POC treatment are comparable to those with NPK + ZA fertilizer. Therefore, it can be concluded that NPK + ZA fertilizer can be replaced by liquid organic fertilizer to reduce production costs. Hence, the use of 20% POC is recommended for farmers to achieve results comparable to those obtained with NPK + ZA. However, for optimal plant growth, a higher concentration of POC, such as 80%, can be applied.

CONCLUSION

Based on the research findings, it can be concluded that the POC made from rice water and blood cockle shells has nutrient content that does not yet meet the standards. Specifically, the C/N ratio is 27.8 (very high), C-Organic is 2.5% (medium), N is 0.09% (very low), P is 359 ppm (very high), K is 412 ppm (very high), and Fe is 10 ppm (medium). The application of various concentrations of POC and NPK + ZA fertilizers significantly affects plant height but does not show a significant impact on the number of leaves and stem diameter. The optimal treatment for growth of chili plants using different concentrations of POC and NPK + ZA is found at a concentration of 80%.

For future research, it is recommended to add plant-based materials that can increase the nitrogen content in POC, particularly from legume families or weeds. Additionally, incorporating aquatic plants such as *Azolla microphylla* could be beneficial. Increasing the proportion of shell flour in the POC formulation is also necessary to enhance nitrogen levels. To achieve optimal effects from applying POC made from rice water and blood cockle shells, it is essential to use a growing medium that meets the plant's needs. A growing medium consisting of a mixture of soil, goat manure, and rice husk charcoal in a 1:1:1 ratio can support optimal growth for chili plants.

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