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The Effect of Liquid Organic Fertilizer Made from Eggshells and Sugarcane Bagasse on the Growth of Cayenne Pepper

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ABSTRACT
Indonesia is an agricultural country. Indonesia's soil structure is fertile and has a tropical climate. Cayenne pepper is a horticultural crop cultivated by farmers. Cayenne pepper production fluctuates from year to year. The leading cause of the lack of cayenne pepper production is land. Efforts are needed to increase production, one of which is intensifying fertilization. One of the liquid organic fertilizers is organic fertilizer from eggshells. Egg shells can be used as an organic fertilizer because they contain nutrients such as calcium carbonate, nitrogen, potassium, and phosphorus. One alternative provider of nutrients for plants is sugar cane bagasse. Sugarcane bagasse contains the elements Carbon (C), Nitrogen (N, Phosphate (P), Potassium (K), Sodium (Na), Calcium (Ca), Magnesium (Mg), Iron (Fe), and Manganese (Mn). Research This study aims to see the effect of liquid organic fertilizer made from egg shells and sugar cane bagasse on the growth of cayenne pepper. This research also aims to study and determine the effect of applying liquid organic fertilizer made from egg shells and sugar cane bagasse on the growth of cayenne pepper. Liquid made from egg shells and bagasse is the best for the growth of cayenne pepper. Research shows that treating liquid organic fertilizer with egg shells and bagasse affects the weight, length, weight per plot, and number of cayenne peppers planted. However, it does not significantly affect the lifespan of cayenne pepper flowers. An 80% concentration treatment of liquid organic fertilizer from egg shells and bagasse showed the best results.

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INTRODUCTION

Indonesia is an agricultural country with most of the population working in the agricultural sector. Indonesia's fertile soil structure and tropical climate make Indonesia suitable for agricultural and plantation use (Purba *et al.*, 2022). Geological factors and strategic geographical location mean Indonesia has considerable opportunities to develop agricultural businesses. Agriculture in Indonesia produces various export commodities, including rice, corn, soybeans, vegetables, chilies, sweet potatoes, and spices (Sofiyuddin *et al.*, 2021; Tiffany, Ernanda and Herdianing, 2023). Indonesia is creating a resilient agricultural system. On August 14, 2022, Indonesia received an achievement from the International Rice

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Research Institute for its resilient agricultural system. According to the Central Statistics Agency, the number of working residents as of August 2020 was 128.45 million. Most people work in the agricultural sector, with 38.23 million workers or around 29.76% of the total (Saragih, 2016).

Farmers cultivate Cayenne pepper, a horticultural plant, because it has many benefits. The technique for cultivating cayenne pepper plants is relatively easy, so farmers prefer this plant for cultivation (Adam, Nurjasmi and Banu, 2019). Cayenne pepper plants have benefits that benefit farmers; apart from easy cultivation techniques, they also have high economic value. Many people like cayenne pepper. Cayenne pepper plants have several advantages that differentiate them from other plants. Cayenne pepper plants can grow well in all conditions and regions. Apart from that, the market opportunities resulting from the cultivation of cayenne pepper plants are vast and extensive, both for sale and for own supplies. The price of cayenne pepper itself also fluctuates (Hatta, 2011). The need for cayenne pepper in Indonesia increases yearly, along with population growth and increasing national market demand. National chili production can seen in Table 1.

Table 1. Area, Production and Productivity of Cayenne Pepper

Year	Area	Production	Productivity
2020	523	381 185	10,25
2021	632	370 202	13,22
2022	643	352 700	11,50
2023	549	359 158	12,97

Source : Badan Pusat Statistik, 2024

Cayenne pepper production in Indonesia tends to fluctuate from year to year. Production in 2020 was 381 185.00, while in 2021, it was 370 202.00 tons, then decreased in 2022 to 352 700.00 tons. 2023, it will be 359 158.00, a slight increase from 2022. Several factors cause cayenne pepper production to fail to meet expectations. The first cause is weather. Cayenne pepper requires hot weather. Cayenne peppers thrive at temperatures of 21 to 29 degrees Celsius during the day and 15 to 21 degrees Celsius at night. Cold temperatures inhibit the growth of cayenne pepper. Cayenne pepper plants require a long growing season with six hours of sunlight. The next cause is rot at the tip of the flower. Cayenne peppers lack calcium (Yusuf, Rauf and Halid, 2018). Lack of nutrition inhibits the growth of cayenne pepper. Cayenne pepper requires phosphorus and potassium to form cayenne pepper. The next cause is due to inadequate pollination. However, land is the leading cause of the need for cayenne pepper production. Efforts are needed to increase cayenne pepper production, including intensification by fertilizing (Syafza, Diamantini and Djaeni, 2021).

Fertilizer is essential for plant growth. The reduced soil fertility level is caused by the continuous use of chemical fertilizers, thereby damaging the biology and physics of the soil. Organic fertilization to increase plant production is a media mixture or fertilizer that can provide nutrients for plants without damaging the biology and physics of the soil. Organic

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fertilization is an effort to add macro and micronutrients to plants while improving soil structure (Ashfaq, Hussain and Athar, 2015; Raksun, Japa and Mertha, 2019).

Organic fertilizer is fertilizer derived from plants, animal waste, animal parts, or other organic waste that has gone through an engineering process in solid or liquid form and can enriched with mineral or microbial materials. Organic fertilizer helps increase the soil's nutrient content and organic matter and improve the soil's physical, chemical, and biological properties (Purba, 2021). Based on the form, organic fertilizers are grouped as liquid and solid fertilizers. Liquid organic fertilizer is organic fertilizer whose final product is in the form of a solution. Meanwhile, solid organic fertilizer is fertilizer whose final product is solid. Liquid and solid organic fertilizers are made from animal and plant waste that contains more than one nutrient element (Bhunia et al., 2021; Ndau et al., 2023).

One liquid organic fertilizer is organic fertilizer from eggshells. Egg shells can be used as an organic fertilizer because they contain nutrients that plants need, such as calcium carbonate, nitrogen, potassium, and phosphorus. This element is perfect for plant growth. Egg shells contain 97% calcium carbonate and an average of 3% phosphorus and 3% magnesium, sodium, potassium, zinc, manganese, iron and copper. The eggshell consists of 97% calcium carbonate; the rest is phosphorus, magnesium, sodium, potassium, zinc, manganese, iron, and copper. The eggshell-soaking water contained a total P of 54.04 ppm, K: 31.00 ppm, and S: 2446.81 ppm. In the eggshell itself, there is a calcium element that is very dominant for plant growth, especially in the formation of cayenne pepper. Providing liquid organic fertilizer from egg shells with a concentration of 7.5% improves plant growth, mainly stem height, number of leaves, and biomass that grows well (Anugrah and Safahi, 2021; Lestari and Saputra, 2023).

One material that also has the potential to be an alternative provider of nutrients for plants is sugar cane bagasse. Sugarcane bagasse contains the elements Carbon (C) at 26.51%, Nitrogen (N) of 1.04%, Phosphate (P) of 6.142%, Potassium (K) of 0.485%, Sodium (Na) of 0.082%, Calcium (Ca) of 5.785%, Magnesium (Mg) of 0.419%, Iron (Fe) of 0.191%, and Manganese (Mn) of 0.115%. With these nutrients, sugar cane bagasse is used as an alternative fertilizer to provide nutrients for plants. Compost derived from sugarcane bagasse waste can increase the height and diameter of Acacia crassic arpa seedlings. Providing bokashi bagasse can increase the height of plants aged 6 WAP. Providing compost from sugarcane bagasse waste can also increase the height of chili plants aged 6 WAP (Freitas et al., 2021; Siregar et al., 2022).

Research (Rahmayanti, 2020) found that egg shells can used as fertilizer, which is good for plant growth, in line with research (Hisani and Mallawa, 2017), which concluded that egg shells are very useful for increasing soil nutrients. Increasing the nutrients in the soil will make the soil fertile, and the plants that grow can produce fruit as expected. Research (Ekawandani and Halimah, 2023) used sugarcane bagasse as plant fertilizer, and it has proved that using sugarcane bagasse as plant fertilizer made plants grow fertile and bear heavy fruit in line with research (Hariani, Sauqina and Putri, 2022) which found that sugar cane bagasse can enhance the nutrients in the soil. The soil will have more potential fertility, so the plants planted will grow fertile and bear maximum fruit. The difference

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between this research and previous research is that this research combines two elements: eggshells and sugar cane bagasse. Apart from that, the following difference from existing research is that this research focuses on cayenne pepper plants. The difference between the research conducted and previously existing research is the novelty of this research.

This research aims to see the effect of liquid organic fertilizer made from eggshells and sugarcane bagasse on the growth of cayenne pepper. This research also aims to study and determine the effect of liquid organic fertilizer made from egg shells and sugarcane bagasse on the growth of cayenne pepper. Apart from that, this research also aims to obtain the best concentration of liquid organic fertilizer made from eggshells and bagasse for the growth of cayenne pepper. This research is vital because cayenne pepper is a primary necessity in life. This research is essential to carry out because cayenne pepper has agricultural potential, which has the opportunity to increase farmers' income, which is correlated with the economy and their welfare. This research is vital because cayenne pepper is one of Indonesia's identities or symbols as an agricultural country.

METHODS

The research carried out consisted of several stages, as presented in Figure 1 below:

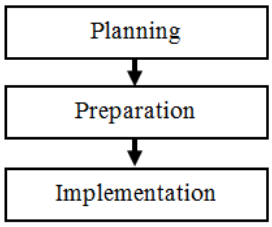

Figure 1. Research Stages (Purba *et al.*, 2020)

The explanation from Figure 1 is:

1. Planning Stage
   Several things are at the planning stage, including scheduling the research time and location. Then, an inventory of the equipment used in the research.
2. Preparation Stage
   The equipment and materials used in the research preparation stage. Such as egg shells and sugar cane bagasse. As well as supporting materials to improve the performance of egg shells and bagasse. The tools used are hoes, plastic drums, shovels, knives, measuring cup scissors, pounding tools, digital cameras, calipers, rulers, sacks, filter cloths, scales, buckets, cloth meters/rulers, stakes/ramps (bamboo), raffia rope, labels, and stationery.
   The concentration between eggshells and bagasse was designed for the preparation stage. The concentration design was carried out repeatedly to ensure the creation of several high-quality experimental materials.
3. Implementation Stage
   In this stage, research starts with preparing the land and making plots. Continue preparing the cayenne pepper seeds where the seeds prepared are the best—after

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that, planting holes are 3 cm deep. Where in each hole, 2 (two) seeds. The planting distance is 20 cm x 30 cm. Next, the plant is thinning. To get plants with uniform growth. Only one plant in each plant hole by cutting off plants that were not growing well using scissors. Then, the bamboo is installed for the two-week-old plants. Then fertilize. Watering liquid organic fertilizer is done in the morning or evening. Treatment was performed five times, namely when the plants were 7, 14, 21, 28, and 35 days after planting. Treatment is given by pouring liquid organic fertilizer evenly over all the leaves and stems of the plant. Then, maintenance is carried out.

Figure 2. Research Stages

RESULTS AND DISCUSSION

Results

Age to Start Flowering

The concentration of liquid organic fertilizer from egg shells and bagasse did not significantly affect the flowering time of cayenne pepper plants—the average age presented in Table 2.

Table 2. Cayenne Pepper Begins to Flower

Treatment	Starting to Flower
Concentration of 0% egg shells and bagasse	36 a
Concentration 20% eggshells and bagasse	35 a
Concentration 40% eggshells and bagasse	35 a
Concentration 60% eggshells and bagasse	35 a
Concentration 80% eggshells and bagasse	35 a

From table 2 it can be seen that the Concentration treatment of eggshells and bagasse liquid organic fertilizer did not have a real effect on the flowering age of cayenne pepper.

Number of Cayenne Peppers (Tree)

Eggshells and bagasse liquid organic fertilizer has a real influence on the number of cayenne peppers per plant. The average number of cayenne peppers per plant in each treatment can be seen in table 3.

Table 3. Number of Cayenne Peppers (Tree)

Treatment	Number of Cayenne Peppers (Tree)
Concentration 0% eggshells and bagasse	7 b
Concentration 20% eggshells and bagasse	10 ab
Concentration 40% eggshells and bagasse	9 b

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Treatment	Number of Cayenne Peppers (Tree)
Concentration 60% eggshells and bagasse	10 ab
Concentration 80% eggshells and bagasse	14 a

Table 3 shows that the application of eggshells and bagasse liquid organic fertilizer increased the number of cayenne peppers. The 80% Concentration treatment produced the highest number of cayenne peppers per plant, namely 14 cayenne peppers, in contrast to the 0%, 20%, 40%, and 60% Concentration treatments—the lowest concentration treatment, 0%, namely seven cayenne peppers.

Long Cayenne Pepper on Tree

Eggshells and bagasse liquid organic fertilizer influence the length of cayenne pepper. The average length of cayenne pepper can be seen in Table 4.

Table 4. Long Cayenne Pepper on Tree

Treatment	Long Cayenne Pepper on Tree
Concentration 0% eggshells and bagasse	67,4 c
Concentration 20% eggshells and bagasse	74 b
Concentration 40% eggshells and bagasse	77 a
Concentration 60% eggshells and bagasse	77 a
Concentration 80% eggshells and bagasse	79,4 a

Providing eggshells and bagasse liquid organic fertilizer can increase the length of cayenne pepper. The 80% Concentration treatment produced the highest length, namely 79.4 cm, and was different from the 0%, 20%, 40%, and 60% Concentration treatments. The lowest treatment was 0%, namely 67.2 cm.

Cayenne Pepper Weight

The concentration of eggshells and bagasse liquid organic fertilizer influences the weight of cayenne pepper per plant. The average weight can be seen in Table 5.

Table 5. Cayenne Pepper Weight

Treatment	Cayenne Pepper Weight
Concentration 0% eggshells and bagasse	143 d
Concentration 20% eggshells and bagasse	171 b
Concentration 40% eggshells and bagasse	170 b
Concentration 60% eggshells and bagasse	160 c
Concentration 80% eggshells and bagasse	197 a

Providing eggshells and bagasse liquid organic fertilizer can increase the weight of cayenne pepper. The 80% concentration treatment produced the highest weight, namely 197 grams, different from the 0%, 20%, 40%, and 60% concentration treatments. The lowest treatment was 0%, namely 143 grams.

Chili Weight (Plot)

The concentration of eggshells and bagasse liquid organic fertilizer really influenced the weight of cayenne pepper per plot. The average weight per plot can be seen in Table 6.

Jurnal Ekonomi
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ESSN 2721-9879 (Online)
https://ejournal.seaninstitute.or.id/index.php/Ekonomi

Table 6. Chili Weight (Plot)

Treatment	Chili Weight (Plot)
Concentration 0% eggshells and bagasse	2,5 c
Concentration 20% eggshells and bagasse	3,12 bc
Concentration 40% eggshells and bagasse	3,04 bc
Concentration 60% eggshells and bagasse	3,52 b
Concentration 80% eggshells and bagasse	4,42 a

Concentration treatment of eggshells and bagasse liquid organic fertilizer can increase weight. The 80% Concentration treatment produced the highest weight per plot, namely 4.42 kg, significantly different from the 0%, 20%, 40%, and 60% Concentration treatments. The lowest concentration treatment is 0% concentration, namely 2.5 kg.

Figure 3. Development Phases of Cayenne Pepper

Discussion

Flowering Age

Providing eggshells and bagasse organic fertilizer to cayenne pepper plants does not affect flowering time. According to (Utami and Singkam, 2022), flowering age and plant height are genetic and environmental factors influencing plant growth and growth characteristics. The response to flowering age in each treatment showed no differences between treatments. In this condition, genetic influence is more significant than environmental influence.

Number of Chilies

Based on research, giving eggshells and bagasse liquid organic fertilizer affects the number of chilies, with the highest amount at 80% concentration being 14 cayenne peppers. Different from Concentration 0% of 7 cayenne peppers. Eggshells and bagasse liquid organic fertilizer make absorbing nutrient content easier. Plants can optimally utilize the nutrients available in eggshells and bagasse to better affect the number of seeds in plants (Prastio and Farmia, 2021). Adding nutrients in organic eggshell fertilizer, such as nitrogen (N), can increase shoot growth, stems, and leaves. In contrast, the element phosphorus (P) increases the growing biomass of roots, cayenne peppers, and seeds, and the element potassium (K) can increase plant immunity from disturbances and attacks by pests and diseases.

Long Cayenne Pepper

Based on the research results, it shows that the application of eggshells and bagasse liquid organic fertilizer has an effect on the length of cayenne pepper, where the length of

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ESSN 2721-9879 (Online)
https://ejournal.seaninstitute.or.id/index.php/Ekonomi

cayenne pepper is found at 80% concentration at 79.4 cm. Different from Concentration 0% of 67.4 cm. The liquid organic fertilizer from eggshells and bagasse is a nutrient that can play a role in increasing soil fertility to support plant growth. This liquid organic fertilizer uses the process.

The statement (Gede, 2020) based on the results of analysis of the content of egg shells and bagasse, it is known that egg shells and bagasse contain the nutrients potassium of 0.121%, calcium of 8.977%, phosphorus of 0.394% and magnesium 10.541%, where the nutrients This is good for plant growth—the iron element in eggshells and bagasse functions as a constituent of active enzymes in photosynthesis and respiration.

Cayenne Pepper Weight

The research results show that applying eggshells and bagasse liquid organic fertilizer affects the weight of cayenne pepper, where the highest weight per plant is 80% concentration at 197 grams. Different from Concentration 0% of 143 grams. The opinion (Criswantara, 2021), states that the use of eggshells and bagasse liquid organic fertilizer has an influence on plant weight and, conversely, has no effect on the age at which plants begin to flower.

Eggshells and bagasse liquid organic fertilizer can work optimally, supported by the surrounding environmental conditions. Eggshells and bagasse liquid organic fertilizer can increase the availability of plant nutrients in various ways. The Ca element is one of the most essential elements. Eggshells and bagasse liquid organic fertilizer contain the Ca element that cayenne pepper needs. Plants that are deficient in Ca will increase curly cayenne peppers. The high plant weight occurs due to the fulfillment of the Ca element needed by plants, especially in the formation of cayenne pepper.

Weight of Cayenne Pepper per Plot

The research results show that applying eggshells and bagasse liquid organic fertilizer affects the weight of cayenne pepper per plot, where the highest weight per plot is 80% concentration at 4.42 kg. Different from a 0% concentration of 2.5 kg. Eggshells and bagasse contain 95.1% mineral elements, 3.3% protein, and 1.6% water. Based on the mineral composition, eggshells and bagasse comprise 98.34% calcium carbonate, 0.84% magnesium carbonate, and 0.75% calcium phosphate. With its abundant eggshells and bagasse content, eggshells and bagasse can be used as plant fertilizer and increase the calcium content of plants. Eggshells and bagasse comprise 95.1% organic matter, 3.3% protein, and 1.6% water. The chemical composition of eggshells consists of 1.71% protein, 0.36% fat, 0.93% water, fiber crude 16.21%, and ash 71.34%, where these nutrients help increase plant growth.

Based on supporting data, the climate from May to July 2024 shows an average temperature of 27.04°C, air humidity of 86.88%, and rainfall of 172.93 mm month-1, where cayenne peppers can grow well at temperatures of 18 - 32°C at air humidity between 80 - 90% and rainfall between 600 - 2,000 mm year-1 because temperature, humidity, and rainfall are supporting factors in the success of cultivation Cayenne pepper.

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https://ejournal.seaninstitute.or.id/index.php/Ekonomi

CONCLUSION

The liquid organic fertilizer treatment of eggshells and bagasse affected the weight of cayenne pepper plant, the length of the cayenne pepper, the weight of the cayenne pepper (plot), and the number of cayenne peppers plant. However, it does not affect flowering time. The oncentration treatment of 80% eggshells and bagasse liquid organic fertilizer is a oncentration of eggshells and bagasse liquid organic fertilizer which shows the best results in the weight of cayenne pepper plant, the length of the cayenne pepper, and the weight of the cayenne pepper (plot).

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