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Organic Fertilizer and Oligochitosan to Increase The Growth of Elephant Foot Yam (*Amorphophallus muelleri* Blume) Plants

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ABSTRACT

Increasing growth of elephant foot yam plants on ultisol which is marginal soil can be attempted by application organic fertilizer in the form of tea waste compost and soaking bulbil as planting material using oligochitosan. This study aims to obtain the concentration of oligochitosan soaking and the dose of tea waste compost on the initial growth of elephant foot yam in Ultisol. This research was conducted on the land of Centre for Roots and Tuber Study Universitas Sumatera Utara, from October 2022 to January 2023. This study used a Randomized Block Design with 2 factors, namely the application of organic fertilizer doses (0; 39.25; 78.5; 117.75 tons/ha) and oligochitosan concentration (0; 1125; 2250; 3375 ppm). The results of the study showed application of organic fertilizer significantly accelerated the age of shoot emergence, increased plant height, stem diameter, age of bulbil emergence and number of bulbils. Soaking oligochitosan significantly increased plant height and number of bulbils. Based on this study, it is recommended to use organic fertilizer in the form of tea waste compost at a dose of 39.25 tons/ha and oligochitosan soaking with a concentration of 1125 ppm to increase the growth of elephant foot yam plants in Ultisol soil.

Keywords: Elephant Foot Yam; Growth; Organic Fertilizer; Oligochitosan; Ultisol

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INTRODUCTION

Elephant foot yam or porang plants are one of the tuber plants that are often found in the forest. Elephant foot yam plants are plants that belong to the Araceae family that have stem tubers. Elephant foot yam plants have good prospects and potential to be developed in Indonesia because they have a high selling value so that they can be an alternative material containing 76.5% starch, 9.20% protein, and 25% fiber content, and have a fat content of 0.20%. In addition, elephant foot yam also contains glucomannan compounds and oxalic acid crystals which are quite high. Glucomannan has many health benefits and is also used in various food and non-food industries such as making shirataki noodles, jelly, and low-calorie food products because of its chewy texture, as a thickener, gel former, or stabilizer (Wahyuni et.al, 2023; Fadia et al, 2023; Rahmawati et al, 2023).

The demand for porang tubers continues to increase, both in fresh form and dry chips. Therefore, the progress of the elephant foot yam business must be increased by increasing intensification and extensification on suboptimal land such as ultisol soil. Ultisol soil has great potential to be developed for expanding agricultural land for food crops but must be balanced with proper plant and soil management. Ultisol soils have high acidity and Al saturation, low nutrient and organic matter content, and the soil is sensitive to erosion (Pratamaningsih et al, 2023; Wahyuni et al, 2023). The addition of organic fertilizers can improve Ultisol soil by increasing soil fertility, improving soil structure, and increasing nutrient availability. One of the organic fertilizers that can be used is compost made from tea waste. The use of tea waste as composting material is useful for plants because tea waste contains various nutrients including organic carbon (C-Organic) 7.3%, magnesium (Mg) 10%, copper (Cu) 20%, and calcium (Ca) 13%. Tea dregs also contain macro nutrients nitrogen (N) 0.32%, phosphorus (P) 0.16%, and potassium (K) 0.22% (Tarashkar et al, 2023). The results of Hakimi et al (2024) research show that the use of tea waste compost can improve soil quality, improve drainage, and stimulate plant root growth. Utilizing tea waste as compost can be an effective and environmentally friendly solution to increase plant productivity.

Efforts that must be considered are the development of elephant foot yam plants in the active growth phase and shortening the dormancy phase. The strategy to overcome the problem of seed dormancy phase and increase the number of seeds by providing oligochitosan to break dormancy. Oligochitosan contains plant polysaccharides, gibberellic acid, indole-3-acetic acid

and zeatin which can accelerate plant growth, obtain good results, increase disease resistance (Sasmita and Haryanto, 2016). Oligochitosan can stimulate the activity of hydrolytic enzymes such as α-amylase and protease. These enzymes play a role in the mobilization of food reserves in seeds, especially starch and protein, thus providing the energy and amino acids needed for germination. Dormancy is controlled by the balance between gibberellin (GA) and abscisic acid (ABA), while oligochitosan is able to reduce ABA levels, which is the main inhibitory hormone in seed dormancy, thereby accelerating the germination process. In addition to playing a role in accelerating dormancy breaking, Oligochitosan also increases plant growth, namely as an elicitor or trigger for physiological responses in plants, which can stimulate the growth of roots, shoots and tubers of elephant foot yam and increase plant resistance to pests and diseases. (Rahman et al, 2025; Suwanchaikasem et al, 2024).

Based on the research results of Sumarwoto and Priyanto (2020) on the growth of elephant foot yam bulbils, oligochitosan should be used as a growth supplement, namely by soaking the bulbils for 2.5 hours in a 1.5% concentration of oligochitosan solution. The results of the study showed that soaking oligochitosan with a concentration of 1.5% and 1%, while the soaking time was 2.5 hours, 5 hours and 7.5 hours with a concentration of 1.5% hours gave the same results in terms of bulb weight and thickness of elephant foot yam bulbs. The results of the study by Harefa et al (2023) also showed that the application of oligochitosan at a concentration of 2250 ppm had a significant effect on accelerating the breaking of elephant foot yam bulbil dormancy, the age of bulbil emergence, increasing the number of bulbils, root length, root wet weight, root dry weight and root volume.

This study aims to analyze the initial growth of elephant foot yam in Ultisol soil by soaking in various concentrations of oligochitosan and doses of organic fertilizer made from tea waste.

MATERIALS AND METHOD

The research was conducted from October 2023 to January 2024 on the experimental land of experimental land Agricultural Tuber Research Center Universitas Sumatera Utara, Medan, North Sumatra Province at an altitude of ± 32 meters above sea level. The research method used was a factorial Randomized Block Design with two factors and consisted of 3 replications. The first factor was organic fertilizer in the form of tea waste compost consisting of 4 treatment levels, namely 0 tons/ha, 39.25 tons/ha, 78.5 tons/ha and 117.75 tons/ha. The second factor was the concentration of oligochitosan, namely 0 ppm, 1125 ppm, 2250 ppm, and 3375 ppm. The total number of sample plants was 192 plants. Planting was carried out using polybags with a volume of 10 kg. The planting medium used was Ultisol soil. While the planting material used was elephant foot yam bulbil.

Solid tea waste used as research material was obtained from PT. Perkebunan Nusantara IV Tea Unit. The starter of tea waste compost uses molasses, EM4 activator, and water which are mixed evenly in one container. The dried tea waste is then given a starter that has been made until everything is evenly mixed. Then the tea waste compost is stored in a container and tightly closed. The tea waste compost is fermented for ± one month to be used as organic fertilizer that will be mixed into the planting medium.During the fermentation process, stirring and controlling the temperature and humidity of the compost are carried out once a week. The compost is stored in an open space but should not be exposed to sunlight. The planting material used in this study used bulbils which began with a selection of uniform bulbil sizes, namely weighing 200 grams which were soaked for 2 hours before being treated with oligochitosan according to the concentration treatment tested. Plant maintenance includes fertilization (nitrogen, phosphate and potassium are given at 45 and 75 days after planting), watering, weed, pest and disease control.

Parameter observations were carried out from when the elephant foot yam bulbils sprouted until 14 weeks after planting (WAP). The parameters observed were the age of shoot emergence, number of leaves, plant height, stem diameter, age of bulbil emergence and number of bulbils. The data were analyzed using the multivariate analysis method and if the results of the variance showed a significant effect, then the analysis was continued using the Duncan Multiple Ranges Test at the α = 5% level.

RESULT AND DISCUSSION

Age of Shoot Emergence

Generally, porang begins to sprout within 2–4 weeks after planting, depending on environmental conditions and seed quality. The age of sprouting and leaf emergence is important to evaluate because it can determine whether the planting method and environmental conditions are optimal or need to be improved. The data in Table 1 shows that the application of organic fertilizer made from tea waste compost had a significant effect on the shoot emergence age of elephant foot yam plants.

Acceleration of shoot emergence age of elephant foot yam plant because tea waste compost is able to meet the nutrient needs required by plants for the leaf formation process or vegetative phase (leaf and root development). By providing a higher dose of tea waste compost, the nutrient content in the soil can increase. In this case, the main focus is on the nitrogen content of 2.78% in tea waste compost. This is in accordance with the statement of Putra et al., (2020) which states that the benefits of nitrogen are to increase plant vegetative growth, soil protein levels, and soil amino acid synthesis. This is in accordance with research by Wan et al., (2015) which states that one of the nutrients needed by plants in large quantities (macronutrients) is nitrogen. Providing tea waste compost can affect the growth of plant root length compared to plants that are not given tea waste compost fertilizer, but soaking bulbils using oligochitosan and the interaction between the two treatments had no significant effect on the shoot emergence age of elephant foot yam plants.

Table 1. Age of shoot emergence treated with organic fertilizer and oligochitosan

Organic Fertilizer	Oligochitosan Concentration				Mean
	0 ppm	1125 ppm	2250 ppm	3375 ppm	
	……..days after planting……..				
0,00 (tons/ha)	9.92	10.58	11.33	11.00	10.71b
39.25 (tons/ha)	10.42	10.75	10.67	9.67	10.38b
78.50 (tons/ha)	10.42	10,17	9.83	10.50	10.23b
117.75 (tons/ha)	9.67	8.17	8.17	8.25	8.57a
Mean	10.11	9.92	10.00	9.86	

Note: The numbers followed by different letters show a significant difference in Duncan's Multiple Range Test at the level of α = 5%.

Tabel 2. Number of leaves, plant height, and stem diameter treated with organic fertilizer and oligochitosan 14 week after plantation

Treatment	Plant Height (cm)	Stem Diameter (mm)	Number of Leaves (strands)
Organic Fertilizer Dosage (tons/ha) :			
0,00 (tons/ha)	9.73 d	6.39 d	6.83
39.25 (tons/ha)	14.45 c	8.01 c	7.21
78.50 (tons/ha)	16.26 b	8.28 b	7.15
117.75 (tons/ha)	16.90 a	8.68 a	7.21
Oligochitosan Concentration			
0.00 ppm	13.61 c	7.42	6.75 c
1125 ppm	13.78 c	8.03	6.85 c
2250 ppm	15.28 a	7.92	7.58 a
3375 ppm	14.67 b	7.97	7.19 b

Note: The numbers followed by different letters in the same column group show a significant difference in Duncan's Multiple Range Test at the level of α = 5%.

Plant Height, Stem Diameter, and Number of Leaves

Vegetative growth of elephant foot yam plant is greatly influenced by the condition of the planting medium. The research on 14 WAP showed that the application of organic fertilizer in the form of tea waste compost had a significant effect on increasing plant height and stem diameter, but did not significantly increase the number of leaves as shown in Table 2.

This study used ultisol soil as a planting medium. The characteristics of physical and chemical properties greatly determine the fertility of ultisol soil which is marginal soil. Handayani et al. (2022) stated that ultisol soil has a level of soil sensitivity to erosion which results in decreased soil productivity, low aggregate stability so that the soil is easily compacted, slow permeability and water holding capacity and low total pore space, low nutrient content so that most of the soil is dry. This soil experiences a decrease in soil physical properties and is difficult to maintain soil moisture. The addition of organic fertilizer to the planting medium increases soil fertility by improving the structure and increasing the soil's capacity to hold water and nutrients. This supports better root development, which contributes to stem growth and plant height. The results showed that the dose of organic fertilizer was directly proportional to the increase in plant height and stem diameter.

The data in Table 2 also show that soaking planting material in the form of bulbils using oligochitosan significantly increases plant height and number of leaves. Soaking oligochitosan at a concentration of 2250 ppm resulted in an increase in plant height and a large number of leaves which was significantly different from other concentrations. Oligochitosan is a chitin derivative compound that has biostimulant properties and is able to increase plant growth, including the early growth of elephant foot yam plants. Oligochitosan can stimulate the production of growth hormones such as auxin and cytokinin, which play a role in cell elongation and cell division, thereby increasing plant height. Novianto (2018) stated that the mechanism for using plant growth regulators can be done by spraying it on the plant parts, but it can also be done by soaking the seeds in the plant

Tabel 3. Age of bulbil emergence and number of bulbil treated with organic fertilizer and oligochitosan 14 week after plantation

Treatment	Age of Bulbil Emergence (days after planting)	Number of Bulbils (bulbils)
Organic Fertilizer Dosage (tons/ha) :		
0,00 (tons/ha)	74.57	1.92 b
39.25 (tons/ha)	74.61	2.81 a
78.50 (tons/ha)	74.96	2.71 a
117.75 (tons/ha)	74.25	2.77 a
Oligochitosan Concentration		
0.00 ppm	74.54	2.58
1125 ppm	74.86	2.69
2250 ppm	74.71	2.65
3375 ppm	74.27	2.29

Note: The numbers followed by different letters in the same column group show a significant difference in Duncan's Multiple Range Test at the level of α = 5%.

growth regulator solution. The administration of plant growth regulators must pay attention to the correct concentration and dosage, because it will affect plant growth, on the other hand, if it is excessive it will inhibit plant growth.

The administration of oligochitosan to porang plants planted on ultisol soil which is soil with suboptimal conditions also has a positive effect on the initial increase in porang plants. Abobatta (2023) stated that in plants planted under abiotic stress conditions, the application of chitosan induces the formation of proline, increased antioxidant enzyme activity, and the formation of total soluble suter which is very effective in minimizing the impact of abiotic environmental stress and oxidative damage improve the initiation of the antioxidant system, and increase photosynthesis rate, consequently improving plant growth and yield.

Age of Bulbil Emergence And Number of Bulbils

The results of the study showed that the application of organic fertilizer made from tea waste had a significant effect on increasing the number of bulbils in elephant foot yam plants (Tabel 3). Organic fertilizers improve soil structure, increase water holding capacity, and provide essential nutrients needed by porang plants for optimal growth. Nutrients such as nitrogen, phosphorus, and potassium in organic fertilizers help the development of leaves and stems, which play a role in the production of bulbils. In addition, the increase in plant biomass due to organic fertilization can increase the number of growing points where bulbils are formed. The research results of Lestari et al (2023) also showed an increase in bulbil formation due to the provision of organic fertilizer.

The results of the analysis of organic fertilizer in the form of tea waste compost are N-total (2.78%), P-total (0.35%), K-total (2.36%), pH (6.67) and C-organic (39.51%). Rokhminarsi et al (2023) stated that the potassium content in organic fertilizer helps translocate photosynthate for the formation of porang plant bulbils. Potassium helps the photosynthesis process in the formation of organic compounds that are transported to the storage organs, in this case the tubers and at the same time improves the quality of the tubers. Potassium also activates the enzymes needed to form starch and protein. The photosynthesis process will run smoothly if the availability of nutrients in the soil is optimal. The optimum availability of potassium can produce large and long roots, so that the roots are able to absorb the nutrients needed by plants

Table 3 shows that immersion of oligochitosan in bulbil as a planting material for porang has no significant effect on the age of bulbil emergence and number of bulbils. However, there was a tendency for an increase in the age of bulbil emergence and number of bulbils in prang plants that received bulbil soaking treatment. Harefa et al (2023) stated that the number of porang plant bulbils is also determined by the number of leaf axils of the porang plant. When the number of leaves increases, the number of porang bulbils obtained also increases. A very important nutrient in increasing the number of plant leaves is nitrogen. The presence of phytosan increases several growth hormones and increases the ability of plants to absorb nutrients that support the formation of more bulbils.

CONCLUSION

The application of organic fertilizer in the form of tea waste compost significantly accelerated the age of shoot emergence, increased plant height, stem diameter, age of bulbil emergence and number of bulbils in elephant foot yam plant. Soaking bulbils using oligochitosan significantly increased plant height and number of bulbils. Meanwhile, the interaction of organic fertilizer application and oligochitosan soaking had no significant effect on the observed parameters. Based on the results of the study, it is recommended to use organic fertilizer in the form of tea waste compost at a dose of 39.25 tons/ha and oligochitosan soaking with a concentration of 1125 ppm to increase the initial growth of elephant foot yam plants in Ultisol soil.

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