Effect of Frequency of Leaf Fertilizer Application and use of Shade on Growth of Porang (*Amorphophallus oncophyllus* Prain.) in Artificial Tin Mining Tailings

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ABSTRACT
Tailings land has the potential to utilize as agricultural land. Tailings land requires improvements such as proper fertilization and has potential to be planted with cultivated plants, such as porang. Porang have potential to be cultivated, because porang have a high import value. This study aims to determine the effect of application foliar fertilizer frequency determine the effect of shade on the growth of porang plants on sand tailings. The research conducted at the Research and Experimental Gardens, Faculty of Agriculture, Fisheries and Biology, University of Bangka Belitung. The research carried out for 4 months, from September 2021 to January 2022. The design used was a Split Plot design with Factorial Randomized Block Design. Shade as the main plot was divided into 2 levels, consist of: the use of shade 60% and without shade. The frequency of application of foliar fertilizers as subplots with 3 levels, consist of: foliar fertilizer application once a week, foliar fertilizer application every 2 weeks and foliar fertilizer application every 3 weeks. If there is a significant effect, further testing will be carried out with the DMRT test with a 95% confidence level. The results showed that the frequency of application of foliar fertilizers and the use of shade significantly affected all parameters except the number of leaves, the number of shoots and the diameter of the shoots. The frequency of application of foliar fertilizer once a week gives the best effect on the growth of porang, the use of shade gives the best effect on the growth of porang, gave to growth of porang frequency of foliar fertilizer application and the use of shade, the frequency of application of foliar fertilizer once a week and the use of shade was best treatment for growth of porang.

Keywords: *foliar fertilizer, frequency, porang, shade.*

1. INTRODUCTION

1.1. Background

The tin mining activity in Bangka Belitung leaves ex-tin mining land in the form of a stretch of sand and is commonly known as tailings land. Area of tin mining in Bangka Belitung reaches 400,000 ha. Tailings land has the potential to be used as agricultural land. Land use after tin mining has obstacles such as irregular landscapes, texture class is dominated by sand and acid soil pH, so tailings land requires improvements such as proper fertilization so that it can be used for agricultural cultivation and has the potential to be planted with cultivated plants, one of which is porang [1]. Porang plant (*Amorphophallus oncophyllus Prain.*) or often referred to as iles-iles is one of the biological richness of Indonesian tubers. Porang was originally found in the Andaman Islands (India) and spread eastward through Myanmar to Thailand and to Indonesia. The porang plant belongs to the family Araceae and belongs to the genus Amorphophallus. Porang experiences a period of dormancy (rest) during the dry season, marked by pseudo stems and dry leaves for 5-6 months. Porang is a shrub (herb) with a single tuber in the soil. Porang grows a lot in the forest because it only requires 50-60% sunlight. Porang plants are plants that require low light intensity so that the provision of shade is made to reduce the intensity of light entering the plant, shade also has a function to prevent plants from being exposed to rainwater.

Shade affects processes in plants such as lowering dark respiration, saturation point, and light compensation point, stomata density. Shade causes shaded plants to

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have a very low dark respiration rate so that the CO2 compensation level$_{is}$ low and the light used for photosynthesis is blocked. Shade will also affect the light that enters the plant will be reduced, this results in the photosynthesis process cannot run optimally so that the formation of plant organs is also hampered such as leaves and stems. Shade for porang plants can be in the form of natural shade such as under teak trees, rosewood, mahogany and artificial shade such as using paranet and UV plastic. The shade in this study used paranet shade with a light intensity of 60%. In addition to paranet shade, porang growth requires macro and micro nutrients contained in fertilizers to support growth and accelerate the development of porang plants.

In general, fertilization on porang uses NPK fertilizer which is applied to the roots through the soil, but in the use of NPK fertilizer the level of nutrient loss is high and the content in NPK fertilizer only contains elements of N, P and K. While plants require nutrients other than N, P and K to support physiological processes and plant growth, this can be fulfilled by giving foliar fertilizer as a complementary fertilizer to the main fertilizer so that the nutrients absorbed by porang plants are more effective. Provision of foliar fertilizer in this study as a complement to NPK fertilizer so that the nutrients needed by porang are fulfilled and able to provide good growth for porang. The application of fertilizer through the leaves has the advantage that the absorption of nutrients runs faster than fertilizer given through the roots, so that the plant will grow shoots faster and the soil is not damaged. Several things that need to be considered in the application of foliar fertilizers are in addition to the type of foliar fertilizer used, the nutrient content of the foliar fertilizer and the concentration of the solution given, as well as the time of spraying interval and the frequency of application of foliar fertilizer [5]. The dose and timing of fertilizer application need to be determined appropriately, so that plant needs are met, soil fertility can be maintained, nutrient loss from the soil can be minimized, and soil and water pollution can be minimized [7]. This study examines the appropriate frequency of foliar fertilizer application for porang growth in post-tin mining tailings media. Based on the description above, this study was conducted to determine the optimal frequency of foliar fertilizer application and whether the use of shade has an effectiveness in increasing the growth of porang plants on post-tin mining tailings media, because in previous studies there has been no research on the frequency of foliar fertilizer application and shading. against porang in post-mining tailings media. This research is expected to be one of the solutions to increase the use of post-tin mining land on Bangka Belitung Island as productive agricultural land and increase the growth of porang plants planted on post-tin mining land.

1.2. Problem Formulation

1) Is there an effect of the frequency of application of foliar fertilizer on the growth of porang plants on sand tailings media?

2) What frequency of application of foliar fertilizer has the best effect on the growth of porang plants on sand tailings media?

3) Is there any effect of using shade and no shade on the growth of porang plants on sand tailings media?

4) Is using shade better than no shade?

5) Is there an interaction between the frequency of application of foliar fertilizers with the use of shade and without shade?

6) Which interaction has the better effect on porang growth?

1.3. Objectives

1) To determine the effect of the frequency of foliar fertilizer application on the growth of porang plants on sand tailings media.

2) To determine the frequency of application of foliar fertilizers which gave the best effect on the growth of porang plants on sand tailings media.

3) Knowing the effect of using shade and without shade on the growth of porang plants on sand tailings media.

4) Knowing the use of shade is better than without shade

5) Knowing the interaction between the frequency of application of foliar fertilizer with the use of shade and without shade

6) Knowing the interaction that gives the best growth of porang plants on sand tailings media.

1.4. Hypothesis

1) The frequency of foliar fertilizer application affects the growth of porang in the post-tin mining tailings media.

2) The frequency of foliar fertilizer application once a week gives the best effect on the growth of porang in the post-tin mining tailings media.

3) The use of shade and no shade affects the growth of porang in tailings media after tin mining.

4) The use of shade has a better effect on the growth of porang in tailings media after tin mining.

5) The interaction between the frequency of application of foliar fertilizers affect the growth of porang in the tailings media after tin mining.

6) The interaction shows the best growth of porang in the media tailings after tin mining is the frequency of application of foliar fertilizer once a week and the use of shade.

2. RESEARCH IMPLEMENTATION

2.1. Time and Place

The research will be carried out at the Research and Experimental Gardens, Faculty of Agriculture, Fisheries and Biology, Bangka Belitung University. The research will be carried out for 4 months, from September 2021 to January 2022.

2.2. Tools and Materials

The tools used in the research are cameras, stationery, scissors, hoes, caliper, analytical scales, polybags and rulers or measuring instruments. The materials used are porang seeds, tailings after tin mining, leaf fertilizer and compost.

2.3. Research Methods

The method used in carrying out this research is an experimental method using a Split Plot design with a Factorial Randomized Block Design (FRBD) pattern. Shade as the main plot was divided into 2 levels, namely:

N = shade

T = no shade

Frequency of application of foliar fertilizer as a subplot with 3 levels, namely:

P1 = fertilizer application once a week

P2 = fertilizer application every 2 weeks

P3 = fertilizer application every 3 weeks

So that there were 6 combinations of treatment levels, each treatment level made 3 replications, each replication consisted of 5 plants that acted as population and samples. The total number of samples was 90 plants.

3. HOW IT WORKS

3.1. Preparation of Planting

Media The planting medium used is tailings of sand after tin mining in Tanjung Gunung Village, Pangkalan Baru District, Central Bangka Regency with tailings aged 10 years after mining activities

3.2. Land Clearing and Land Management

After the location of the land is determined, then the land is cleared of weeds. The pit is dug mechanically using a hoe to fill the tailings to create an artificial tailings medium. The depth of the hole reaches 40 cm, the hole is made into beds of 3 blocks and consists of 6 rows. The sand is transported to the planting hole using arco, the land is loosened mechanically using a hoe and the beds are made with a length of 2 m, a width of 50 cm and a distance between beds of 35 cm.

3.3. Shade Installation

The shade used is paranet shade with an incoming light intensity of 60% which has been measured using a lux meter. Paranets were installed by tying them using ropes and nails in the shade house with the same slope and height under the shade treatment (N).

3.4. Preparation of Seedlings

The porang seeds used come from Bulbil that already have buds. Seedlings are planted in small polybags, the seedlings are ready to be transplanted to the land 60 days after sowing. The criteria for ready-to-plant seeds are 4-5 leaves, the seeds are free from pests and diseases and the leaves do not turn yellow.

3.5. Planting

Holes are made with a spacing of 35 cm and a depth of 40 cm. Next, the hole is composted. Planting is done one week after composting. Planting is done in the morning. Then the planting hole is dug, the seeds are inserted into the planting hole that was previously dug, after planting the seeds are then watered.

3.6. Maintenance

Porang plant maintenance includes watering, replanting, weeding, fertilizing, and controlling pests and diseases. Watering is done in the morning and evening, watering is adjusted to weather conditions. Embroidery is done if there are plants that die, replanting 4 weeks after planting. Weeding is done mechanically on beds that have been overgrown with weeds. Fertilizing with inorganic fertilizers 45 days after planting using NPK fertilizers. Fertilizers are applied in a circular manner around the tree trunk.

3.7. Foliage Fertilizer Application

The fertilizer used is gandasil B fertilizer in the form of granules then dissolved in water. If the leaf area is wider and the plant is getting bigger, the concentration of foliar fertilizer is adjusted to the condition of the plant. Fertilizer is sprayed onto the leaves using a 20 ml perfume spray bottle.

3.8. Observations

Observations were made on plant growth variables as the main observation parameters and observations were made on the microclimate as secondary observations. The main observations consist of:

3.8.1. Plant Height

Increase Plant height gain was measured once a month. Measurement using a ruler or tape measure from the base of the stem to the growing point. How to calculate the increase in plant height is the height of the plant at the time of observation - the height of the plant when transplanting.

3.8.2. Increase in the number of leaves

Increase in the number of leaves is calculated once a month. Leaves that are counted are leaves that have fully opened. How to calculate the increase in the number of plant leaves is the number of leaves at the time of observation - the number of leaves when transplanting.

3.8.3. The increase in the diameter of rods

Increase in the diameter of the rods was measured once a month using a digital caliper. The diameter of the stem measured was 5 cm from the base of the stem. How to calculate the increase in plant stem diameter is the diameter of the plant stem at the time of observation - the diameter of the stem when transplanting.

3.8.4. The icrease in the diameter of crown

Increase in the diameter of the crown is measured once a month using a meter. The way to calculate the increase in the diameter of the plant crown is the diameter of the plant crown at the time of observation - the diameter of the plant crown when transplanting.

3.8.5. Leaf Color

Observation of leaf color was carried out using the *Munsell Color Chart*. Leaf color grouping consists of (1.) *Hue*, (2.) *Value*, (3.) *Chroma*. The leaves that will be observed are leaves that come from the parent shoot, one leaf is observed for each stalk. Leaf color observations were carried out every 2 weeks. Secondary observations consist of:

3.8.6. Air Temperature and Humidity

Observations were made while watering the plants. Watering is adjusted to weather conditions if there are shoots that have appeared on the porang plant. Observations were made with a *Digital Hygrometer Thermometer*.

3.8.7. Soil Temperature and Soil Moisture

Observation of soil temperature and humidity was carried out while watering the plants. Watering is adjusted to weather conditions if there are shoots that have appeared on the porang plant. The tool used to measure soil temperature is a soil *thermometer* and soil moisture is a *Soil Moisture Meter* by plugging the sensor part into the planting medium.

3.9. Data Analysis Data

Analysis used variance (ANOVA) at the 95% confidence level. If there is a significant effect, further testing will be carried out with the DMRT test with a 95% confidence level.

4. RESULTS AND DISCUSSION

4.1. Results

Table 1. Results of analysis of physical and chemical soil properties of post-tin mining tailings in Tanjung Gunung Village, Central Bangka.

Parameter	Value*	Description*
Texture :		
Sand (%)	91	Sandy
Dust (%)	6	
Clay(%)	3	
PH H_2O	6.01	Slightly Acidic
PH N KCl	4.53	Slightly Acidic
C-organik (%)	0.37	Very Low
N-Total (%)	0.05	Very Low
C/N Ratio #	7	Very Low
P_2O_5 Available (mg/Kg)	43.21	Very Low
P_2O_5 Potential (mg/100g)	18.30	Very Low
K_2O Potential	8.13	Very Low
K+ cmol(+)/kg	0.11	Very Low
Na^+ cmol(+)/kg	0.06	Very Low
Ca2+ cmol(+)/kg	0.39	Very Low
Mg2+ cmol(+)/kg	0.11	Very Low
KTK cmol(+)/kg	1.24	Very Low
Base Saturation (%)	54.03	Very Low
Al3+ cmol(+)/kg	0.46	Very Low
H+ cmol(+)/kg	0.04	Very Low

Remarks: The results of the analysis in the lab. Bengkulu BPTP testing 2020. Soil characteristics criteria based on Hardjowigeno 2010.

Result of soil analysis in Environmental Biotechnology Laboratory PT Biodiversitas Biotechnology Indonesia Bogor, West Java (Table 4) shows that the soil at the study site has a sandy texture,

with 91% sand content, 6% dust and 3% clay. Soil is slightly acidic with PH H2O 6.01 organic matter contained in the soil such as C-organic (%), N-total, P-total, K-total are very low. The soil cation exchange rate and base saturation are very low.

The results of variance showed that the frequency of foliar fertilizer application and the use of shade (Table 2) in the post-tin mining tailings media on the growth of porang plants had a significant effect on the parameters of plant height increase, stem diameter, crown diameter, shoot height, shoot stem diameter and number of bulbil, Parameters observed for the number of leaves, the number of shoots and the diameter of the shoots showed no significant effect.

Table 2. The results of the variance of the frequency of foliar fertilizer application and the use of shade in the tailings media after artificial tin mining.

Variebel by Observed	Shade		Foliar Fertilizer		KK(%)
	F val	Pr>F	F value	Pr>F	
Height plant (cm)	0.61	0.45^{tn}	1.50	0.26^{tn}	1.92
Number of Leaves (strands)	0.21	0.94^{tn}	0.13	0.87^{tn}	16.64
Stem Diameter (mm)	14.06	0.002**	0.13	2.40^{tn}	8.97
Head Diameter (cm)	10.87	0.006**	1.88	0.19^{tn}	21.45

Note: F val = F value, Pr > F = probability value, ** = very significant effect, * = significant effect, tn = not significant effect, KK = coefficient of diversity.

The results of the variance showed that the interaction between the frequency of foliar fertilizer application and the use of shade (Table 3) in the post-tin mining tailings media on the growth of porang plants had a significant effect on the parameters of plant height, stem diameter and crown diameter.

Table 3. interaction table between the frequency of foliar fertilizer application and the use of shade

Variebel by Observed	Interaction		KK(%)
	F val	Pr>F	
Height Plant (cm)	3.6	0.03*	1.92
Number of Leaves	0.06	0.99^{tn}	16.64
Stem Diameter (mm)	4.91	0.01*	8.97
Head Diameter (cm)	3.11	0.04*	21.45

Based on Figure 1, it can be seen the average plant height growth porang shows a graph that tends to increase every month but in the 4th month the porang plants wilt because they have entered a dormant period. The P1 treatment with the use of shade gave better results than the other treatments.

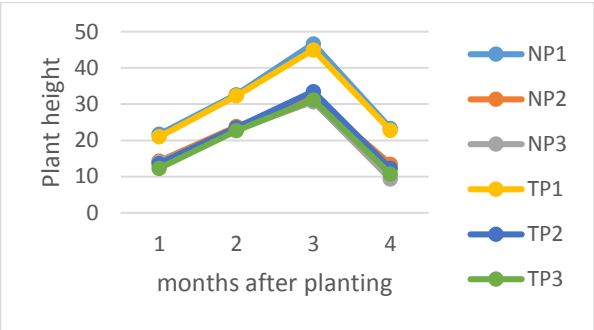

Figure 1 Frequency of foliar fertilizer application and the use of shade on the parameters of plant height growth.

Graph of the number of leaves added for 4 months after planting with the frequency of application of foliar fertilizer and the use of shade (Figure 2). The average number of leaves tends to increase every month and the treatment of NP1 with TP1 shows the highest results on the number of leaves.

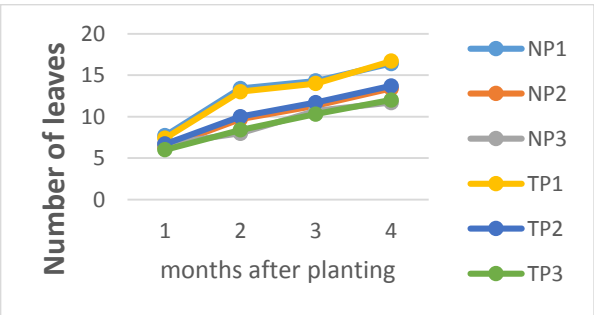

Figure 2. The frequency of application of foliar fertilizers and the use of shading on the parameters of increasing the number of leaves.

Based on the results of the Duncan Multiple Range Test (DMRT) it shows the frequency of application foliar fertilizers and the use of shade (Table 4) gave significantly different effects on the parameters of stem diameter and crown diameter. Parameters of plant height showed no significant effect on the frequency of foliar fertilizer application and the use of shade on the tailings media after artificial tin mining artificial tin mine.

Table 4. The result results of the Duncan Multiple Range Test (DMRT) observation of porang plant growth with the frequency of foliar fertilizer application and the use of shade on tailings media after artificial tin mining.

Treatment	Parameter		
	Plant Height	Stem Diameter	Head Diameter
P1	**42,36**	**12,46 a**	**25,17 a**
P2	41,693	11,84 a	23,00 a
P3	41,69	11,12 a	19,76 a
N	**42,05**	**12,74 a**	**26,42 a**
TN	41,75	10,87 b	18,87 b

Description: The numbers followed by different letters in the same column show a significant difference in the 95% DMRT test.

4.2. Discussions

The frequency of application of foliar fertilizers and the use of shade can increase the growth of porang plants on tailings land after artificial tin mining. The application of foliar fertilizers with various frequencies gave different effects on the growth of porang plants. Basedon the results of the variance (Table 2), the frequency of application of foliar fertilizers with different time periods gave a significant effect on the observed parameters of plant height,stem diameter and crown diameter. Generally the process of nutrient uptake into plants can occur through active and passive transport. The mechanism of nutrient uptake through leaves begins with the entry of nutrients through the stomata, exodesmata and cuticle in the epidermis to the plant cytoplasm. The rate of nutrient absorption in leaves is influenced by the status of available nutrients in the soil. If the nutrient content in the soil is low, then the absorption of nutrients through the leaves is relatively faster [9].

Based on the results of further tests, the frequency of foliar fertilizer application and the use of shade had a significant effect on the parameters of stem diameter and crown diameter (Table 4), while plant height parameters showed no significant effect. Shade can affect the growth and yield of porang plants, because porang is very tolerant of shade and can grow well with light intensity ranging from 40-60% [10]. According to [2] the conditions for growing porang plants are the required light intensity ranging from 50-70% with non-muddy land having good drainage, sandy loam texture that is clean of weeds and an optimal pH level of 6-7 good for plant growth. porang. Shade affects lower respiration rates of plants than plants grown under continuous full light. Low light intensity can affect root, wood, leaf biomass, and photosynthetic rate [11].

The growth of porang plants in this study is influenced by the frequency of application of foliar fertilizers and shading is also influenced by environmental factors, one of which is temperature. According to [8] temperature can affect several activities of plants such as root growth, absorption of nutrients and water in the soil, photosynthesis, respiration and photosynthate translocation. Each type of plant has a minimum, optimum and maximum temperature in the rate of photosynthesis. The average temperature in the porang research area ranges from 25-33^{0}C, this temperature is the optimum temperature or suitable for porang growth [3]. Based on the results of soil analysis, the soil in the area of research conducted at the Environmental Biotechnology Laboratory of PT Biodiversitas Biotechnology Indonesia, Bogor, West Java.

The parameters for increasing plant height and number of leaveswere best seen in the frequency of application of foliar fertilizers once a week (figures 1 and 2). While the shade and no shade treatments showed an average that tended to be almost the same every month for the observation parameters. [4] cultivation of porang has developed in open land without shade, especially in the last 3 years. The interactions that show the best growth of porang on post-tin mining tailings media are the frequency of application of foliar fertilizer once a week and the use of shade. According to [6] the application of fertilizer through the leaves provides a quick but temporary response so that the application must be repeated and in accordance with the recommendations. The higher the dose and the more frequent the application of foliar fertilizer given the higher and optimal nutrient content obtained by the plant. This is in accordance with the results of the study, namely the more often the application of foliar fertilizer is given, the better for porang growth. Shade is a treatment that tends to be better than without shade even though the average growth is not much different, because the growth of porang in open land without shade shows good growth.

5. CONCLUSIONS

Based on the research that has been done, several conclusions can be drawn, namely:

1) Application of foliar fertilizers with various frequencies gives different effects on the growth of porang plants.

2) The frequency of application of foliar fertilizer once a week gave the best effect on the growth of porang in tailings media after artificial tin mining.

3) The use of shade had a significant effect on the parameters of the increase in stem diameter and crown diameter, while the parameters for the increase in plant height and number of leaves showed no significant effect.

4) The use of shade gave the best effect on porang growth in the tailings media after artificial tin mining compared to the use without shade.

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