Influence of growth media and bulbil sizes on plant growth and corm yield of porang (Amorphophallus muelleri Blume)

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Abstract. Porang (Amorphophallus muelleri Blume) is usually cultivated on the field under the tree as natural shading. Porang can also be grown on a pot containing limited amount of growth media. The present research work was carried to evaluate the minimum amount of growth media required for optimum growth and corm yield. The study used bulbils (10 g/bulbil and 20 g/bulbil) and corm (+ 15 g/corm) sown on growth media of 2.5 kg, 5.0 kg and 7.5 kg/pot as treatments. Each treatment was arranged in completely randomized design and was replicated 3 times. Plant height, plant diameter, shoot dry weight, diameter and thickness of corm and fresh weight of corm were measured to evaluate the influence of the treatments on growth and corm yield of porang. The plant growth of porang measured as plant height, plant diameter, shoot dry weight was improved when the planting materials were planted on bigger size of growth media. Bigger size of bulbil caused better growth of porang on each growth medium. The effect of plant materials and the size of growth media on porang growth was in parallel to its effect on corm yield measured as corm diameter, corm thickness and fresh weight of corm. The result of the present study suggests to use bigger bulbil and bigger size of growth media when planted on polyethylene bag. Corm as planting material was better than bulbil because less size of corm produced similar plant growth and corm yield compared to bigger size of bulbil. Therefore, the use of corm as planting material is more favorable to bulbil.

1. Introduction
Relatively higher price of porang (Amorphophallus muelleri Blume) benefitted more to the farmers as compared to other tuber crops like cassava and sweet potato [1, 2]. High price of porang could be related to its function as one important source of functional food, due to the presence of high content of glucomannan in corm of porang [3; 4]. Glucomannan contained in corm of porang was reported to play a role in maintaining and relieving some human illness [5-14].

Porang is usually cultivated on the field under the tree as natural shading [15-20]. High economic value of porang drives some farmers to grow porang on pot containing growth media to produce corm and bulbils. Additional reason for growing porang on pot is to prevent corm and bulbils from stealing. Soedarjo [21] revealed better porang growth and yield on a pot containing 8 kg Alfsiol soil by using bigger size of bulbil as planting material. Smaller bulbil produced smaller canopy of porang plants, as indicated by shorter plant height and lower shoot dry weight [21], suggesting the use of smaller size of growth media.
The smallest amount of growth media for optimum growth and corm yield of porang on a pot is required to minimized the cost of providing the growth media. The present research work was carried out to evaluate the optimum amount of growth media needed to grow porang by using bulbils and corm as planting materials.

2. Materials and Methods

2.1. Soil and plant preparation

Alfisol soil used in the present research work was obtained from Probolinggo Regency, East Java, Indonesia. The soil was taken from as deep as 20 cm. The soil was air dried, crushed and sieved to pass through the 0.5 mm sieve. The soil was sent to the Soil and Plant Chemical Laboratory of Indonesian Legume and Tuber Crops Research Institute (ILeTRI)(ISO/IEC 17025-2017) for chemical analysis. The soil was mixed thoroughly with manure (1:1 by volume) as growth media. The growth media of as much as 2.5 kg (1), 5.0 kg (2) and 7.5 kg were put into polyethylene bag. The soil was watered to a water field capacity before sowing the porang by employing the method described previously [21]. The soil was watered to maximum water holding capacity and was kept overnight to drain out the excessive amount of water to achieve the water field capacity.

The present research used local variety of porang obtained from Probolinggo regency, East Java, Indonesia. Bulbil and corm of porang were used as plant materials. Selection was done to obtain healthy and approximately uniform size of bulbil and corm. The weight of bulbil and corm used in the present research work was listed in table 1. One from the uniform germinated bulbil or corm was sown for each soil (A, B and C).

| Treatment | Bulbil Weight (g) | Standard deviation | Treatment | Bulbil Weight (g) | Standard deviation | Treatment | Bulbil Weight (g) | Standard deviation |
|-----------|-------------------|--------------------|-----------|-------------------|--------------------|-----------|-------------------|--------------------|
| A-1       | 10.49             | 0.76               | B-1       | 20.47             | 0.95               | C-1       | 15.70             | 0.21               |
| A-2       | 10.40             | 0.62               | B-2       | 20.33             | 0.65               | C-2       | 16.33             | 0.46               |
| A-3       | 10.47             | 0.76               | B-3       | 20.13             | 0.59               | C-3       | 15.98             | 0.91               |

A and B are bulbil sizes, C is corm size. Number 1, 2 and 3 are growth media sizes of 2.5 kg/pot, 5.0 kg/pot and 7.5 kg/pot.

Porang was watered in every other day by using tap water to maintain water field capacity during the experiment. Porang was fertilized with 300 kg NPK/ha. By assuming the porang population of 40,000/ha, each porang plant on each pot was fertilized with 12 g NPK/ha. Fertilizer of as much as 4 g/pot was applied by dibbling (2-3 cm deep) at 25 days after sowing (DAS), 50 DAS and 80 DAS, respectively. After applying fertilizer, the plant was watered to make fertilizer easily available to porang plants. Hand weeding was done to prevent porang plants from nutrient and water competition. Insecticide and fungicide were sprayed whenever necessary to prevent plants from insects and diseases damages.

2.2. Experimental design

The present research work was carried out in the paranet house of Indonesian Legume and Tuber Crops Research Institute (ILeTRI) from November 2019 to Mei 2021. The average shading in the paranet house was 60%+1.2% during the undertaking of the research work.

The treatment used in this research comprises of bulbil sizes (A and B) and corm size (C) planted on growth media of 2.5 kg, 5.0 kg and 7.5 kg/polyethylene pot (Table 1). Thus, there are 9 treatments. Each treatment was arranged in completely randomized design and was replicated three times. Plant height, plant diameter, dry weight of shoots, diameter of corm, thickness of corm and fresh weight of corm were measured to evaluate the effect of pot size and planting materials on plant growth and corm yield of porang. Plant height was measured from the soil surface upto the tip of the shoot.
Plant diameter was measured at the shoot right on the soil surface. Corm diameter and corm thickness was related to corm fresh weight [21]. Thus, measurement of these variables required to estimate the fresh weight of corm. Shoot and leaves were oven-dried and weighed. All data of each observation was analyzed by employing Standard Deviation from three replicates.

3. Results and Discussion

3.1. Soil chemical properties

Table 2 shows the chemical properties of Alfisol soil. Alfisol soil used in the present study is considered to be neutral, the pH was 6.2. Low sodium content and electric conductivity indicates that the soil will not cause sodium toxicity to the plants [22]. This Alfisol soil is considered to be fertile because porang plants did not show nutrient deficiency and grew normally [21, 22]. Nitrogen contained in Alfisol soil seems to be low to support normal plant growth (Table 1). Application of 200-300 kg NPK fertilizer was found to be enough to supply N to porang plants [21, 22].

Table 2. Soil chemical properties of saline and Alfisol soils.

| Chemical properties               | Alfisol soil |
|-----------------------------------|--------------|
| pH H₂O (1:5)                      | 6.20         |
| N-Total (Kjedahl) (%)             | 0.05         |
| P₂O₅ Olsen (ppm)                  | 96.50        |
| K-NH₄OAc. pH 7.0 (Cmol⁻/kg)       | 0.88         |
| C-Organic-Walkley & Black (%)     | 1.15         |
| Na (Cmol⁻/kg)                     | 0.50         |
| Ca (Cmol⁻/kg)                     | 1.05         |
| Mg (Cmol⁻/kg)                     | 3.94         |
| Electric Conductivity (EC) (µS/cm)| 17.14        |

3.2. Plant height

Figure 1 depicted the plant height of the first shoot at 60 DAS (A) and plant height of the second shoot at 70 DAS (B). In general, there is an increase of porang plant height (the first and the second shoot) when the growth media was increased from 2.5 kg/pot to 7.5 kg/pot. The use of bigger bulbil (20 g) produced higher plant height of the first and the second shoot of porang than the use of 10 g bulbil as plant material. Interestingly, plant height of the first shoot at 60 DAS and the second shoot of porang at 70 DAS showed comparable between the use of smaller size of corm (+ 15 g/corm) and the use of 20 g bulbil plant material. The result of the present research suggests to use bigger size of bulbil as plant material. Soedarjo [21] also suggests to use bigger bulbil as plant material to produce better porang plant growth measured as plant height. Corm is considered be better than bulbil as plant material, because plant height of the first and the second shoot was attained by smaller size of corm (+ 15 g/corm) and by 20 g bulbil was similar.
3.3. Shoot diameter

The first shoot diameter of porang at 60 DAS varied and depended on plant material and the size of growth media (Fig. 2A). As depicted on Fig. 2A, the diameter of the first shoot was significantly bigger when bigger size of bulbil used at particular size of growth media. For example, the first shoot diameter of treatment B1 (14.3 mm) was higher than that of treatment A1 (11.2 mm) (Fig. 2A). Figure 2A also showed that increasing size of growth media promoted higher diameter of the first shoot of porang. However, increasing growth media to 7.5 kg/pot did not increase diameter of the first shoot further. Interestingly, corm (+ 15 g/corm) produced diameter of the first shoot similar to bulbil (20 g/bulbil). The diameter of second shoot at 70 DAS, however, was comparable among the plant materials grown on each size of growth media tested (Fig. 2B). The result of the present study is in accordance to the result reported by Soedarjo [21] that the use of bigger bulbil as plant material produced bigger plant diameter.

3.4. Shoot dry weight

The shoot of porang on each planting material was significantly affected by the size of growth media (Fig. 3). An increase of size of growth media increased significantly the shoot dry weight. The increase of shoot dry weight due to the size of growth media is parallel to the increase of plant height and shoot diameter (Figs. 1 and 2). Therefore, both plant height and shoot diameter could be used as indicators for porang growth measured as shoot dry weight. An increase of shoot dry weight due to the
use of 5.0 kg and 7.5 kg growth media (as compared to 2.5 kg growth media) was 58.8%, 121.3% when bulbil size of 10 g was used as planting material. An increase of shoot dry weight due to the use of 5.0 kg and 7.5 kg growth media (as compared to 2.5 kg growth media) was 69.5%, 95.5% when bulbil size of 20 g was used as planting material. An increase of shoot dry weight due to the use of 5.0 kg and 7.5 kg growth media (as compared to 2.5 kg growth media) was 52.7%, 81.6% when corm of +15 g was used as planting material.

3.5. Corm diameter and thickness
The effect of plant material and the size of growth media on corm diameter and corm thickness was depicted on Figures 4A and 4B. The corm diameter was increased significantly with an increasing size of growth media for each planting material (Fig. 4A). The highest corm diameter on each planting material was found to be achieved when highest amount of growth media was used. Corm thickness was also significantly improved with an increase of growth media in each planting material (Fig. 4B). However, the use of corm (+15 g) on growth media of 5.0 kg and 7.5 kg did not result in significant difference of corm thickness, even though a slight increase was noticed with an increase of growth media to 7.5 kg/pot (Fig. 4B). The use of bigger bulbil (20 g/bulbil) produced higher corm diameter and thickness than the use of smaller bulbil as planting material on the same size of growth media (Figs. 4A and 4B).
3.6. Fresh weight of corm

Figure 7 shows the qualitative performances of corm yield as affected by planting materials (A, B and C) and the size of growth media (1, 2 dan 3). On each planting material, an increase of the size of growth media resulted in bigger corm (figs.7A, 7B and 7B). Figure 7D depicts a significant increase of corm yield with an increase of the size of the growth media for each planting material. Buia et al. [23] also reported that bigger size of growth media increased significantly the yield of tomato. The further increase of corm fresh weight was attained when bigger bulbil was used as planting material. This result indicates that higher corm yield would be achieved when bigger bulbil was planted on higher volume of growth media. Soedarjo et al. [22] also revealed higher corm yield when bigger bulbil was used as planting material. The use of bigger planting material resulted in higher corm yield was also reported by Douglassa et al. [24]. A comparable corm yield was shown by planting material of both corm (+ 15 g/corm) and bulbil (20 g/bulbil) planted on each size of growth media. This result indicates that to achieve a comparable corm yield, the amount of planting material was lower when using corm as planting material. Consequently, less cost of planting material is needed. Thus, this result suggests to use corm as planting material whenever available.

Figure 5. Effect of planting materials (A, B, and C) and the size of growth media (1, 2 dan 3) on the performances of porang corm and the fresh weight of porang corm (D). Bars on Figs. 7A, 7B and 7C indicate 5 cm. A1, A2, A3, B1, B2, B3, C1, C2 and A3 are described in Tabel 1.
4. Conclusions
The plant growth of porang measured as plant height, plant diameter, shoot dry weight was improved when the planting materials were planted on bigger size of growth media. Bigger size of bulbil caused better growth of porang on each growth medium. The effect of plant materials and the size of growth media was in parallel to its effect on corm yield measured as corm diameter, corm thickness and fresh corm yield. The result of the present study suggests to use bigger bulbil and bigger size of growth material when planted on polyethylene bag. Corm as planting material was better than bulbil because less size of corm produced comparable plant growth and corm yield to bigger size of bulbil. Therefore, the use of corm as planting material is more favorable to bulbil.

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