Effect of sucker weight and seedling site on the growth of sago seedlings (*Metroxylon sago* Rottb.) in Papua

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Effect of sucker weight and seedling site on the growth of sago seedlings (*Metroxylon sago* Rottb.) in Papua

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Abstract. This study aims to obtain sucker weight and appropriate seedling site as a source of sago seeds by using seedling techniques in polybags to improve seed quality on sago cultivation. The experiment used a factorial design arranged in a randomized block design with three replications. Factor A, namely sucker weight, consisted of <999 g, 1000-1499 g, 1500-1999 g and > 2000 g. Factor B is the seedling site, consisting of laying seeds in the field, greenhouse and paranet of 60%. The results of the study showed that there was no interaction between the sucker weight combined with the seedling site, but the sucker weight had a significant effect on the number of rachis and the number of primary roots per plant and the percentage of life seedlings. Higher rachis growth was 3.8 obtained from medium-sized sucker weights (1000-1499 g and 1500-1999 g) and the highest number of primary roots was 41.3. It is obtained at sucker weights of 1000-1499 g. Meanwhile, the higher percentage of seedling survival was obtained at medium to large sucker weights of 66.3-71.0%. Thus, multiplication of sago seeds using medium-sized sucker on polybag media is highly suggested.

1. Introduction

Sago (*Metroxylon sago* Rottb.) has long been widely cultivated or maintained by small farmers and traditional communities in several regions of the archipelago, such as Riau, South Sulawesi, Molucas, and Papua [1,2]. Especially in Molucas and Papua, sago has long been an important source of carbohydrates for the population. If developed, sago can be an alternative food that can alleviate or even overcome the problem of national food security [3,4]. About 50% of the world's sago crop, or 1,128 million/ha, grows in Indonesia [5], and 90% of that amount, or 1,015 million ha, grows in the provinces of Papua and Molucas [6,7].

Sago plants in Papua are high in genetic diversity [8]. This conclusion is reinforced by [9] which states that Papua is the center of the largest genetic diversity of sago in the world so that sago plants in this area need to be protected from genetic erosion and genetic flight abroad and even the conversion of sago land functions into residential areas.

There were 60 types of sago in Papua that grow in the areas of Jayapura, Manokwari, Merauke, and Sorong [10]. Research from the University of Papua (2001) revealed 22 accessions of sago in Biak and Supiori, while 20 accessions of sago were found in Sentani [11]. The increasingly diverse uses of sago and the demand for sago flour have led to massive exploitation of the plant without any effort to rehabilitate it [9]. Such conditions have occurred in Papua and may lead to the extinction of several sago accessions that have high production potential [12,13]. Sago is the largest carbohydrate source in the world because it can produce 200-400 kg of dry starch per stem [14,15]. The local accession of sago in Sentani, locally called Pharaa (prickly sago), was able to produce about 975 kg of dry starch per stem [16,17].

Considering the great potential of sago and the condition of sago land which is starting to erode due to population growth, it is necessary to develop sago plants both through cultivation and rehabilitation of sago forests. In order to support the cultivation business, it is necessary to provide good sago seeds, because it needs to be supported by appropriate sago seedling techniques. It was stated that for the establishment of large-scale sago plantations, the availability of superior seeds is the main obstacle and sago propagation plays an important role in providing quality sago seeds [18,19]. Therefore, the sago development program to ensure the sustainability of production requires technology for providing seeds [20].

Basically, there are three methods of propagation of sago seedlings namely generative propagation method, vegetative propagation method and tissue culture propagation method. Sago propagation is generally carried out vegetatively through suckers [21]. The method of generative propagation of sago by seed is rarely used because the percentage of germination of sago seeds is very low [22]. There are two vegetative propagation techniques for sago, namely the immersion technique using a raft in running water and the propagation technique using polybag media. Generally, farmers in Papua use the technique of immersion in water before planting in the field, although on a small scale. The technique of propagation using polybag media is rarely used, even though it greatly facilitates adaptation of plant roots when transferred to planting land compared to immersion techniques in the water. However, the extent of the success of propagation techniques in polybags needs to be studied because generally sago roots prefer water or at least are closer to water such as river or swamp habitats. The parameters used to measure the success of the seed propagation technique using polybags were shoot growth, root growth and seedling life presentation. The purpose of this research is to obtain a source of quality seeds to support sago cultivation in Papua through seedling techniques in polybags.

2. Material and methods

Field research at the Papua AIAT laboratory complex, Sentani District, Jayapura Regency, Papua Indonesia, (2° 34' 25" east longitude, 140° 30' 17" latitude, 50 m asl) during the growing season from June to October 2019. Temperature of the study site (max. 31.4°C , min. 29.4°C and mean 30.6°C), humidity (max.75%, min. 66.5). The materials used in this study were a local sago accession *Yeba*, greenhouse, 60% paranet, polybag, soil media and organic fertilizer, buffer wood, wash basin, watering dipper, growth stimulant and fungicide. The tools used are: temperature thermometer, caliper, small meter, pruning shears, shovel and writing utensils.

Figure 1. Soaking sago saplings using a fungicide solution and growth stimulant before being transferred to the nursery according to the treatment.

The study used a factorial design arranged in a Randomized Block Design with three replications. Factor A sucker weight, consisting of; < 999 g (B_1), 1000-1499 g (B_2) 1500-1599 g (B_3) and > 2000 g (B_4). Factor B of the nursery consists of field (S_1), greenhouse (S_2) and 60% paranet shade (S_3). Seed selection is based on certain criteria based on the origin of the seedling and plant weight. Seedlings are taken from shoots that come from the base of the stem and the shoots used are those from the mother tree that are ready to harvest or nearing harvest. Before planting the sucker in soil mixed with organic fertilizer in polybags with a ratio of 3:1, the head of the sago saplings was dipped in a fungicide solution for 10 minutes with a concentration of 2 g/liter of water and air-dried for 30 minutes to avoid fungal infection at the base sago. Planting was carried out in polybags filled with mixed soil according to the treatment studied, namely the weight of the tillers and the nursery. Maintenance is carried out by watering adequately twice (morning and evening) during the four-month assessment, then cleaning the suckers from dirt or other adhering objects and controlling plant pests and diseases according to the symptoms of the attack. Observations on the parameters include growth components consisting of: Survival precedent of seedlings (calculated based on the number of seedlings that survive to the age of 4 months after sowing).

$$\text{Seed survival percentage} = \frac{Number\ of\ live\ seeds\ \ (n)}{Number\ of\ seeds\ planted}\ x\ 100\% \quad (1)$$

Information:
Number of live seeds (n)
Number of seeds planted (initial seeds)

1. Number of rachis/branches/midribs (counted for all branches formed with the criteria of having perfect leaves).
2. Number of primary roots. Observations were made at the end of the study (performed on the rhizome of each sample plant. Observations on the location of the initial primary roots before planting on newly formed primary roots were also carried out (whether there was initiation of early primary roots before planting) and the time of primary root formation in the nursery. On the percentage of life seedlings, the number of primary roots was carried out at the end of the study, while observations of the number of rachis formed were carried out every month.

Statistical analysis was performed using Analysis of Variance (ANOVA) at a 5% significant difference level. Differences between treatments were tested using the Least Significant Difference (LSD). Data were analyzed using the statistical program GenStat 18th edition and Microsoft Office Excel program 2010.

3. Results and discussion

3.1. Number of rachis initiated

The results of analysis of variance revealed no interaction between the weight of sucker and seedling site on the number of rachis initiated, however sucker weight had a significant effect on the number of rachis per plant. The average number of rachis per plant affected by different sucker weights is shown in Table 1.

Table 1. The number of initiated rachis on sucker weights at different ages of 4 MAS observation.

Treatment *Sucker weight (g)*	Number of rachis initiated/plant
B_1 (< 999) small	2.83 ± 0.74^a
B_2 (1000-1499) medium	3.83 ± 0.29^b
B_3 (1500-1999) medium	3.83 ± 0.29^b
B_4 (>2000) big	2.00 ± 1.70^a
LSD 5%	2.84

Notes: Numbers accompanied by the same letter show no significant difference in the 5% LSD test. MAS: month after sowing.

The study showed that the number of rachis initiated increased significantly following the weight of the sucker used as a seed source and reached the highest sucker weight of (1000-1499 g) and (1500-

1999 g), which was 3.83/plant (Table 1). It was different when using sucker weight >2000 g as a seed source, it actually decreased the number of rachis per plant and was not significantly different from sucker weight (<999 g). These results can explain that the use of medium-sized suckers as a seed source was able to increase the number of rachis per plant by 35.3% compared to small-sized suckers (<999 g) and was able to increase rachis per plant by 91.5% compared to large-sized suckers (>2000 g). The low increase in the number of rachis per plant in small suckers was thought to be due to the fact that the starch content as an energy source stored in the hump did not meet the needs of the seeds plus the slow root growth rate so that it could not absorb maximum nutrients for photosynthesis. Likewise, what happened to large suckers was thought to be due to the maximum speed of seedling growth so it should be transferred to the field instead of in polybag planting media. Research result [23], sago saplings with medium size have high growth power (92.14%) presumably because these saplings are in an optimal growth phase, so that at the time of sowing, these saplings have high growth power and good seeds are obtained. Furthermore, it was said that small sago saplings were thought to be in the early phase of growth and would enter optimal growth, therefore their growth power was lower than medium sized tillers but higher than large saplings. The ability to grow large sago saplings is lower than that of small and medium sized sago palms. This is presumably because most of the energy resulting from metabolism is used for wound healing, thus inhibiting the growth of shoots (new leaves) and roots [24]. Thus, the results of this study indicate that the size, in this case the weight of the sago saplings used as plant material, greatly determines the ability to grow these saplings into seeds.

3.2. Number of primary roots

The results of analysis of variance showed that there was no interaction between sucker weight and seedling place on the number of primary roots, but sucker weight had a significant effect on the number of primary roots per plant. The average number of primary roots per plant due to the effect of different sucker weights is shown in Table 2.

Table 2. The number of primary roots per plant at different sucker weights at the age of 4 MAS observations.

Treatment *Sucker weight (g)*	Number of primary roots/plant
B_1 (< 999) small	8.89 ± 1.50^{a}
B_2 (1000-1499) medium	41.33 ± 3.50^{c}
B_3 (1500-1999) medium	25.67 ± 4.50^{b}
B_4 (>2000) big	18.89 ± 4.12^{b}
LSD 5%	2.84

Notes: Numbers accompanied by the same letter show no significant difference in the 5% LSD test. MAS: month after sowing.

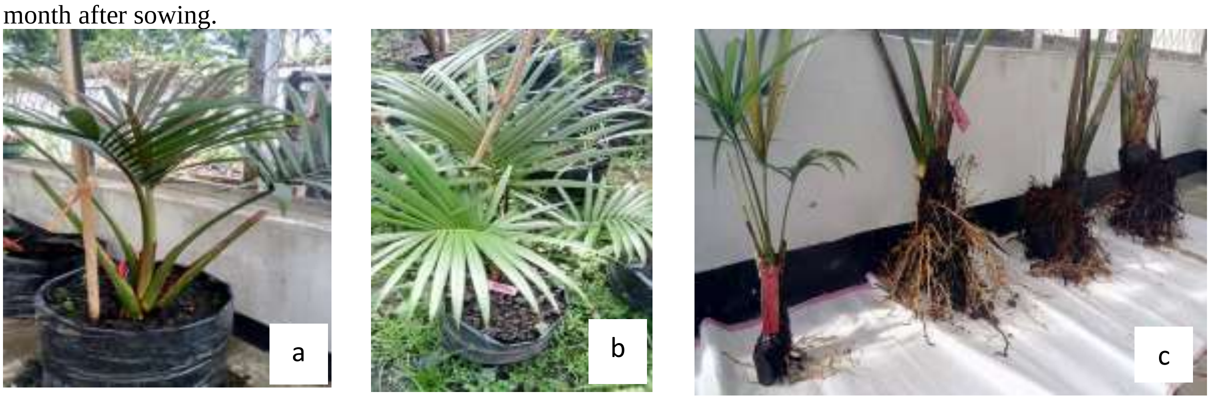

Figure 2. Performance of 3 months old sago seedlings in greenhouse (a), paranet 60% (b) and appearance of plant roots after 4 months (c).

The results of the study showed that the number of primary roots obtained in the medium-sized sucker weight (1000-1499 g) was significantly higher than the number of primary roots in the other three treatments. These results also showed that although the number of primary roots at sucker weights (1500-1999 g) and sucker weights (>2000 g) was significantly higher than sucker weights (<999 g) which resulted in fewer primary roots, the two treatments were not significantly different. These results can explain that the low number of primary roots in small sucker weights (<999 g) is thought to be more due to the slow root growth rate because the energy source needed for seedling growth is still obtained from the mother plant. As for the weight of medium and large suckers, shoots have begun to form, followed by the emergence of roots. The average number of the highest primary roots in the 1000-1499 g sucker weight treatment produced in this study was more (41.3) than the results of the Bogor Agricultural University research in 2013 which produced the highest primary root at the same sucker weight as much as 18.2 [25].

3.3. Seedlings survival percentage

The results of analysis of variance showed that there was no interaction between sucker weight and seedling site on the percentage of life seedlings, but sucker weight had a significant effect on the percentage of life seedlings. The average percentage of life seedlings because of different sucker weights is shown in Table 3.

Table 3. The percentage of seedling survival on different suckers at different ages of 4 MAS observation.

Treatment *Sucker weight (g)*	Percentage of seedlings survival (%)
B_1 (< 999) small	43.44 ± 3.09^a
B_2 (1000-1499) medium	66.33 ± 7.57^b
B_3 (1500-1999) medium	71.00 ± 6.00^b
B_4 (>2000) big	65.67 ± 4.04^b
LSD 5%	2.84

Notes: Numbers accompanied by the same letter show no significant difference in the 5% LSD test. MAS: month after sowing.

Table 3 shows that the percentage of live seedlings obtained at the weight of the small sucker (<999 g) was significantly lower than the percentage of live seedlings in the other three treatments. The results of this study also showed that although the number of live percentages in the sucker weight treatment of (1000-1499 g), (1500-1999 g) and sucker weight (>2000 g) was significantly higher, the three treatments resulted in a percentage of live seedlings that were not significantly different. These results can explain that the low percentage of life in the weight of small suckers (<999 g) is thought to be due to the fact that the base of the rachis attached to the hump is not strong enough so that it is easily detached when a shock occurs due to taking seeds from the mother plant and this causes a high percentage dead seeds. The results of this study are better than the results of this study [16] with power percentage grew by 30%, but lower than the research results of PT. National Timber and Forest Product, with sago saplings growing capacity of 82.00% [18]. However, the research results of PT. National Timber and Forest Product uses a container of running water so that it is in an aerobic condition so that the plant roots get enough oxygen. Because sago seedlings sown on a raft have a higher growth rate than sago seedlings sown in pots filled with soil but in stagnant water conditions [15].

3.4. The relationship between sago seedlings growth and seedlings survival percentage

The ability of sago seedlings to survive is largely determined by the amount of photosynthesis compared to respiration that occurs through the growth of rachis and roots, as illustrated in the regression equation model between the rachis initiated number and the number of primary roots growing by percentage survival of seedlings showing a positive linear relationship, $Y_{1} = 4.58 + 47.32$, $R^2 = 0.94$ (Figure 3a);$Y_2 = 0.63x + 46.67$, $R^2 = 0.80$ (Figure 3b).

This equation model indicates that the growth of rachis and primary roots plays an important role in increasing the seedling survival percentage, so that if the initiated rachis and primary root growth to absorb nutrients experience a slowdown in growth, it causes a lack of energy supply for photosynthesis and most of the energy will be used for respiration then gradually seedling growth will slow down and die. The equation model in (Figure 3a) can explain that an increase in the number of rachis initiated (x) by one unit will cause an increase in the seedlings survival percentage (y) by 4.58%. This equation model can explain the form of the relationship between the number of rachis initiated and the seedling survival percentage by 94 percent while 16 percent is explained by other factors. The results of the regression analysis in (Figure 3b) show that an increase in the number of primary roots (x) by one unit in sago seedlings actually causes an increase in the percentage survival seedling of sago (y) by 0.63%. This equation model can explain the form of the relationship between the increase in the primary roots number and the percentage survival seedlings of sago by 80 percent while 20 percent is explained by other factors. The results of this study indicate that sago seedlings can be propagated using polybags because they produce high growth power. Tillers that will be used as

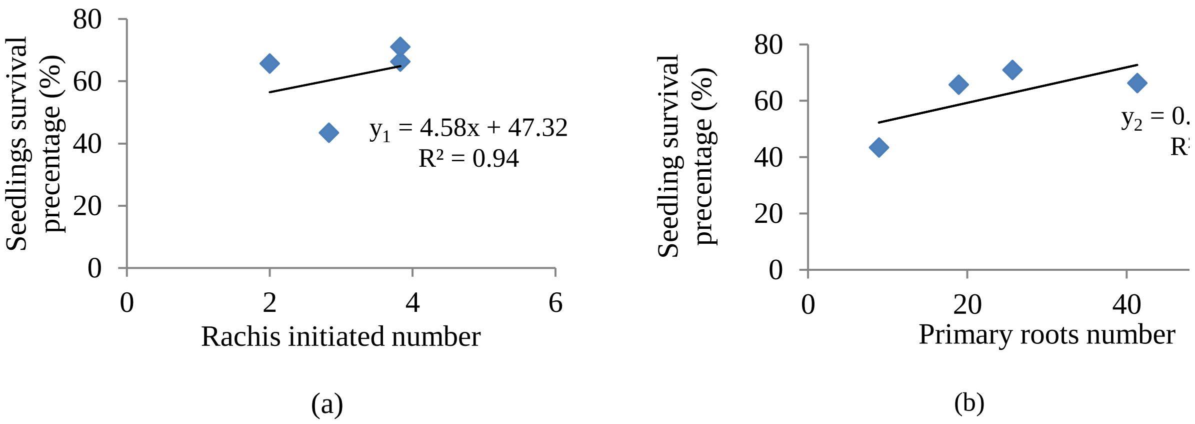

Figure 3. The relationship between sago seedlings growth and seedlings survival percentage.

plant material to produce seeds must have high growth power so that vigor seeds will be obtained.

4. Conclusions

The weight of the medium-sized sucker consistently provided better seedling growth when viewed from the number of rachis initiated, the number of primary roots and the percentage of seedling survival. The best sucker weights to be used as seeds for sowing in polybags were medium size (1000 - 1499 g) and (1500-1999 g) with 3.83 rachis growth and 66.33 - 71.00% growth potential.

Declarations

Contribution: In this article, Alberth Soplanit and Merlin K Rumbarar acts as the main contributor, Petrus A Beding acts as a member contributor.

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