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Leaf growth character of sago palm based on sucker weight at the rosette stage

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Abstract. The study aimed to obtain suitable sucker recommendation for good growth and development of sago plant in the field and to determine the leaf growth characters based on sucker weight at the rosette stage. The research was conducted at Sago Plantation Site located in Pembuniang Village, West Malangke Sub-district, North Luwu Regency from September to December 2017. The first observation was made at 16-month after sucker transplanting in September 2017, the second in November 2017. To determine statistical differences between the sucker weight of 1-3 kg and 3-6 kg, T-Test (Independent Sample T-Test) was used and Principal Component Analysis (PCA) was used to determine the relationship between the leaf growth characters. The results show the suckers with weight of 3-6 kg grow better than that of 1-3 kg as indicated by the number, width and length of the leaflets, and the number of leaves and rachis length. Sucker with 3-6 kg weight have a closer relationship between variables.

1. Introduction

The population densities in Indonesia must continue to be balanced with adequate food systems and availability in terms of food security [1]. To achieve food security in Indonesia, the use of local commodities is essential, because food in Indonesia is still dominated by rice making import values to increase. One of the potential local commodities in Indonesia is sago palm. The national carbohydrate requirement of 2012 is 34 million tons while sago productivity reaches 20-40 ton ha⁻¹ year⁻¹ dry starch, hence 1 million ha of sago plant able to fulfil all requirement of Indonesian carbohydrate [2]. Sago can be one of the most important sources of nutritious food/starch in the near future [3, 4].

Indonesia has the largest sago potential in the world, more than 90% the world's sago land area (5.5 million ha) is in Indonesia. The sago palm can be found in some provinces in Indonesia except West Nusa Tenggara, East Nusa Tenggara, DKI Jakarta, and Yogyakarta. In South Sulawesi, sago is one of staple food especially in Luwu Raya. The district of North Luwu has a land potential of 1,590



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ha (38.8% of the total potential of land developed in South Sulawesi), potentially as the largest sago-producing district in South Sulawesi [5, 6].

Sago palm development is considered very important. In addition to having many benefits, sago palm can also grow with high tolerance to the environment. Although sago productivity can reach 20 to 40 tons ha⁻¹ year⁻¹ dry starch, sago palms in Indonesia only produce 15-25 tons ha⁻¹ year⁻¹ dry starch [2, 7].

Sago palms in Sulawesi grow naturally until can be harvested. The growth and development of sago must be optimal to obtain high productivity [8]. Good sago cultivation practice should be implemented including preparation of seedlings. The first step in sago cultivation is to determine good seeds (suckers). Sago palm that can produce good and quality sago starch comes from good plants and sourced from good suckers as well.

Research related to the sucker weight has been done by the previous researcher and obtained the result that a higher percentage of live plants were obtained from heavier sucker weights [9]. Research about the sucker weight of sago palm in certain locations is important to be investigated. Sago farmers in Pembuniang Village have a habit to cultivate the sago plant without applying fertilizers. However, there are no criteria for optimum sucker weight to achieve good growth in the field. Research on sago palm growth from different sucker weight is important to obtain stable sucker recommendation for the good growth and development in the field and to determine the leaf growth character of sago palm based on sucker weight at the rosette stage.

2. Materials and Methods

2.1. Selection of plant sample

The research was conducted at Sago Plantation Site located in Pembuniang Village, Malange Barat Sub-district, North Luwu Regency, Indonesia (2°49'10.9"S 120°19'22.1"E). In this study, the weight of sucker used was divided into two groups, 1-3 kg and 3-6 kg. Selected plants were plants with sucker weight of 1-3 kg and 3-6 kg and were cultivated using a conventional method. The sucker cut leaves were laid on a floating raft in the pond. The suckers were nursed for about 3 months then weighed before planting. 18 plants were observed consisted of 9 plants each for sucker weight of 1-3 kg and 3-6 kg, respectively.

2.2. Observation and data analysis

The first observation was made at 16-month after sucker transplanting in September 2017, the second in November 2017. The number, width and length of the leaflets; the number of leaves; rachis length, petiole length and plant height were measured. The mean leaf angle and transmission coefficient were analyzed in December 2017 using CI-110/120 Digital Plant Canopy Imager CID Bio-Science Inc.

To determine statistical differences between the sucker weight of 1-3 kg and 3-6 kg, T-test (Independent Sample T-test) was used. In addition, Principal Component Analysis (PCA) was conducted to determine the relationship of leaf growth character.

3. Results and discussion

Table 4 shows that the sucker weight had significant differences in the number, width and length of leaflets; the number of leaves and rachis length. Suckers of 3-6 kg of weight have more food reserves to grow faster. According to Pinem [10], suckers with the lower weight of food reserves decrease more and more while in suckers with higher weight food reserves support optimal growth of sago seedlings even though the roots and leaves have not grown properly.

Different suckers weight has different growth, according to Jayanti [11], the growth difference of each sucker is not only determined by the goodness of a sucker, it is also determined by several factors, one of which is seed/sucker weight. The number of leaves between the sucker weight of 1-3 kg and 3-6 kg showed a significant difference in September and November 2017. Haryono [12] stated that in the cultivation of plants must consider the number of leaves for sunlight can be fulfilled. In this

study, the sucker weight of 3-6 kg have a higher number of leaves and transmission coefficient is also higher so it is suspected that the number of leaves has not been a limiting factor of the plant.

Table 1. Observation of growth parameters (September and November 2017) and statistical difference by t-test

Leaf Growth Parameters	Sucker Weight	Measurement Values	
		September 2017	November 2017
Number of leaflets	1-3 kg	16.54 ^b	22.97
	3-6 kg	19.52 ^a	23.78
Width of leaflets (cm)	Sig. (2-tailed)	0.04	0.83
	1-3 kg	3.27 ^b	3.70
	3-6 kg	3.64 ^a	4.09
Length of leaflets (cm)	Sig. (2-tailed)	0.04	0.06
	1-3 kg	45.07 ^b	50.73
	3-6 kg	51.40 ^a	58.56
Number of leaves	Sig. (2-tailed)	0.04	0.05
	1-3 kg	15.00 ^b	18.22 ^b
	3-6 kg	17.33 ^a	20.67 ^a
Rachis length (cm)	Sig. (2-tailed)	0.03	0.04
	1-3 kg	49.10 ^b	64.92
	3-6 kg	64.67 ^a	85.77
Petiole length (cm)	Sig. (2-tailed)	0.04	0.06
	1-3 kg	63.49	73.44
	3-6 kg	70.14	82.90
Plant height (cm)	Sig. (2-tailed)	0.10	0.13
	1-3 kg	166.00	192.78
	3-6 kg	203.56	249.56
	Sig. (2-tailed)	0.09	0.05

Numbers followed by the same alphabetical letters (a) indicate the absence of a significant difference by t-test ($\alpha = 0,05$).

Table 2. Observation on plant canopy character (Desember 2017) and statistical difference by t-test

	Sucker Weight	Measurement Values
		Mean Leaf Angle (°)
	1-3kg	
	3-6kg	23.22
	Sig. (2-tailed)	0.63
Transmission Coefficient	1-3kg	0.51
	3-6kg	0.53
	Sig. (2-tailed)	0.71

Numbers followed by the same alphabetical letters (a) indicate the absence of a significant difference by t-test ($\alpha = 0,05$).

A related study on the number of leaves on palm trees was conducted by Fransedo [13] who suggested that plants with a young age were preferred to support their growth by maintaining the number of leaf more than mature plants. The sample used in this study is a plant at the rosette stage. The results of the study in the previous table show that the number of leaves at the end of the observation ranged from 18.22-20.67 which means that the plant samples that had been observed were

plants at the rosette stage. Irawan [14] stated that the sago palm at the rosette stage produced less than 120 leaflets in most cases.

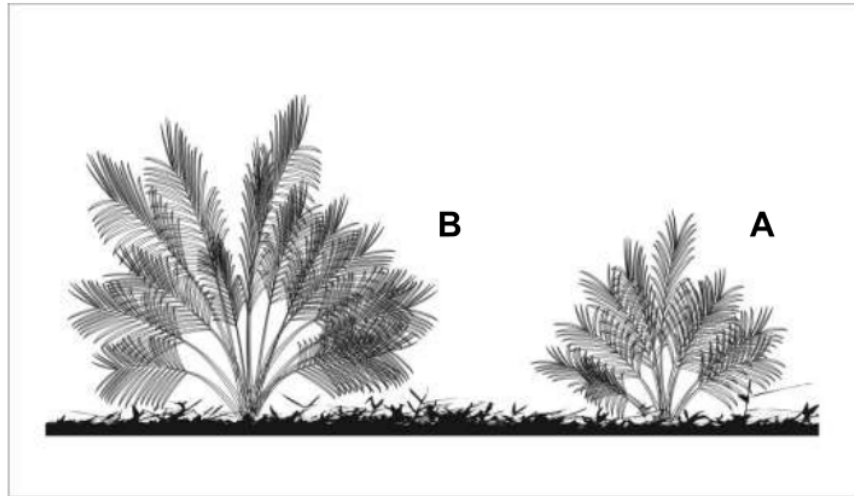
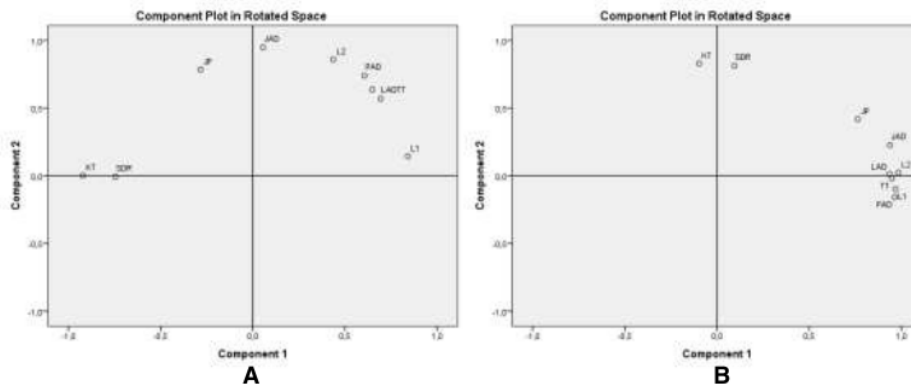


Figure 1. Plant architecture by leaf growth characters: (a). 1-3 kg, (b) 3-6 kg

Figure 1 shows the plant architecture by leaf growth characters, made with t-test value analysis on the observation variable. The values that have been obtained from the results of the study are presented in the form of images (plant architecture) to obtain an overview of each character of growth based on the sucker weight. Sucker weight of 3-6 kg grows better than that of 1-3 kg as indicated by t-test.



- Note:
- L1 = petiole length
 - L2 = rachis length
 - PAD = length of leaflets
 - LAD = width of leaflets
 - LAD = number of leaflet
 - JP = number of leaves
 - TT = plant height
 - SDR = mean leaf angle
 - KT = transmission coefficient

Figure 2. Loading plot of Principal Component Analysis (PCA): (a). 1-3 kg, (b) 3-6kg

Suckers of 3-6 kg weight have a closer relationship between variables (Figure 2). According to Nuraeni et al. [15], PCA is used to determine the most influential variables, in terms of the angle magnitude formed between the variables tested. The smaller angle formed between the variables tested, the greater the relationship. When compared with the average value, some of these variables show higher values in 3-6 kg sucker weight. The difference based on PCA results is the smaller number of leaves of 1-3 kg sucker weight is also in line with the fewer number of leaflets. According to Irawan [14], the number of total leaves and the number of leaflets were significantly correlated.

4. Conclusions

The suckers of 3-6 kg weight grow better than that of 1-3 kg as indicated by the number, width and length of leaflets; the number of leaves and rachis length. Suckers of 3-6 kg weight have a closer relationship between variables.

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