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Difference of Growth Indicators of Sago Palm in Alubijid of Mindanao, Dalat of Sarawak and Tobimeita of Sulawesi

Comparative Study on Growth Indicators of Sago Palm in Southeast Asia I

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Abstract The comparative growth study on sago palm, which consisted of determining the population density, the palm height, the diameter at the ground level and the number of leaves, in the quadrates of the cultivation field of Alubijid, Mindanao, Philippines, Dalat, Sarawak, Malaysia and Tobimeita, Sulawesi, Indonesia was performed from 1992 to 1999. The mean population density of sago palm, having no stem development, but pseudostem with more than 5 cm in diameter, in Alubijid (alluvial soils; Fluvisols) was 3025–3800 palms per ha in 1998 and 3825–4600 palms per ha in 1999. These figures showed higher population density than those recorded in Dalat of Sarawak (tropical peat soils; Histsols) and Tobimeita of Sulawesi (alluvial soils; Fluvisols) where the farmers produced the starch from the stem of sago palm. The sago palms have no clear stem development in the study quadrates of Alubijid, because the farmers do manage few control of the sucker numbers to grow the leader palm in the cluster after a fire in 1993. The mean palm diameter at the ground level in Ajubijid ranged from 24.8 to 31.7 cm in 1998 and 25.7 to 28.1 cm in 1999, which indicated smaller figures than those in Dalat and Tobimeita. The mean number of living leaves varied from 5.1 to 6.3 per palm in 1998 and 5.5 to 5.7 per palm in 1999, smaller number of leaves than those in Dalat and Tobimeita, concluding that the farmers in Alubijid manage to cut and remain at least upper three or four living leaves to produce the thatch every three months.

Key words: Mindanao, Population density, Sago palm, Sarawak, Sulawesi

ミンダナオ・アルビヒット，サラワク・ダラットおよびスラウェシ・トビメイタにおけるサゴヤシ生長形質の相違

東南アジアにおけるサゴヤシ生長形質の比較研究 I.

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要約　フィリピン・ミンダナオ・アルビヒット，マレーシア・サラワク・ダラットおよびインドネシア・スラウェシ・ケンダリのサゴヤシ栽培地内にコドラートを設定し，個体密度，樹高，地表面における直径，葉数などのサゴヤシの生育に関する調査を 1992 年から 1999 年に実施し，それらの経年変化を明らかにした．アルビヒット(沖積土)におけるサゴヤシ(高胸直径 5 cm 以上を計測)の平均個体密度は，3025～3800 本 ha^{-1} (1998 年)および 3825～4600 本 ha^{-1} (1999 年)で，ダラットおよびケンダリで得られた個体密度に比べて，きわめて高かった．1993 年の火災後，アルビヒットの

サゴヤシ栽培地のサゴヤシは，幹を形成していなかった．これは，サゴ澱粉の生産を目的とするダラットおよびケンダリとは異なり，アルビヒットではサゴヤシ葉を屋根材として利用するためのサゴヤシの栽培管理の差によるとみられる．アルビヒットのサゴヤシの平均地表面直径は，24.8～31.7 cm (1998 年)および 25.7～28.1 cm (1999 年)で，ダラットおよびケンダリの平均地表面直径よりも小さかった．アルビヒットの平均生葉数は，5.1～6.3 (1998 年)および 5.5～5.7 (1999 年)で，ダラットおよびケンダリのそれより明らかに少なく，アルビヒットにおけるサゴヤシの栽培が，屋根材のための生葉の採取に重点があり，3 カ月ごとに上位 3 から 4 葉を残して下位葉を採取する維持管理を実施した結果であると結論することができる．

キーワード　個体密度，サゴヤシ，サラワク，スラウェシ，ミンダナオ

Introduction

Sago palm (*Metroxylon sagu*), which is known to accumulate more than 200 kg of starch in the stem, originated from Moluccas of Indonesia to Papua New Guinea. Presently it is widely distributed in Southeast Asia especially in Thailand, Malaysia and Indonesia. Malaysia, being equipped with multi-million dollar worth of processing machinery, was known to be the principal exporter of sago starch to the world market over the last 50 years and it plays a vital role in the economy (Zulpilip et al. 1991). Japan imports approximately 10 thousands tons of sago starch from Malaysia and Indonesia (Kobayashi 1993).

In the Philippines sago palm is widely distributed in some municipalities in Davao, Sta. Cruz, Matanao of southern Mindanao and Alubijid, El Salvador, Villanueva of northern Mindanao. However, it is considered as a minor importance in the economy of the country level. In Alubijid, Misamis Oriental, more than one hectare was planted with sago palm. The municipality of Alubijid is located at the Province of Misamis Oriental in the northern part of Mindanao. Sago palm in Alubijid areas was mainly utilized for roofing materials (thatch) as additional source of income and food starch among the poor farming households (Josue and Okazaki 1998). The tolerance of sago leaves as thatch was 3–5 years, while nippa and coco leaves are 1–2 and 2–3 years, respectively. In Mindanao, however, more than 2500 km^2 are low lying and unutilized marshland areas in which limited plant of economic importance grows. These wetland areas in northern Mindanao are considered as potential areas for sago growth. The objectives of this study are to report sago growth and the growing areas in Mindanao and to compare the sago growth in Alubijid of Mindanao, Dalat of Sarawak and Tobimeita of Sulawasi.

Study site

The study site of Mindanao is located at Alubijid, Misamis Oriental, approximately 20 to 30 minutes drive from Cagayan de Oro City (Fig. 1), classified as tropical monsoon (Am) climate. More than one hectare of alluvial soil (Fluvisol) with a shallow peat horizon was planted with sago palm in the farmer's backyard (Photo. 1). The palms having no stem were about 4–5 years without leader palms, because the areas were fired 5 years ago. Sago palms having pseudostem (not stem) of more than 5cm in diameter at the breast height were counted. Three sample plots measuring 20 × 20 m within the sago field were taken for the purpose of this study. The farmers

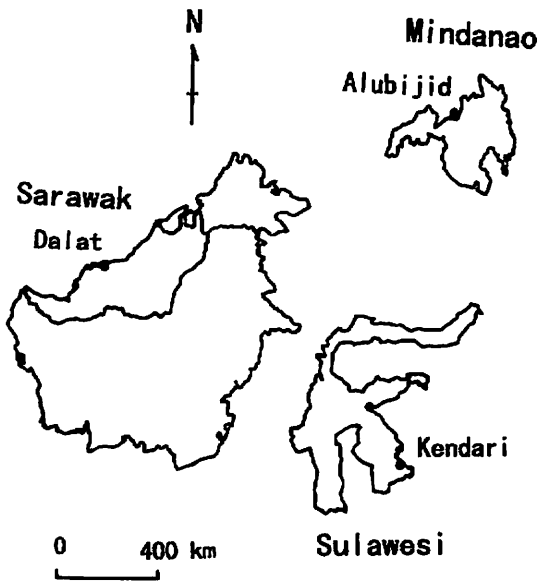

Fig. 1 Map of the study sites.

Photo. 1 Sago palms in Alubijid, Misamis Oriental, Mindanao, Philippines.

Photo. 3 Thornless sago palm in Tobimeita, Kendari, Sulawesi, Indonesia.

Photo. 2 Sago palms in Dalat, Srawak, Malaysia.

manage to cut the sago leaves down until leaving 3 living leaves in order to take the thatch.

The study site of Sarawak is located at Balan and Sungai Talau Peat Research Station of LCDA (STPRS), 10 km from Dalat town (Yamaguchi et al. 1994; Yamaguchi 1998), classified as tropical rainfall (Af) climate (Photo 2). The sampled sago palms were 4–12 years within 225 ha of the station. In this study 4–12 years sago palms in the arbitrary quadrates (about 400 m^2) were selected to compare the growth indicators. The sago palms grown on deep and shallow peat soil classified with Malaysian soil classification system (Tie et al. 1991), correspond to Fluvisol, were countered and measured every year from 1992 to 1997 (6 years). The smallest management for sago palms, slashing bush and cutting suckers, has been carried out to take the starch finally (Jong and Flach 1995).

The study site of Sulawesi is located at Tobimeita, Kendari (Okazaki 1998), classified as tropical rainfall (Af) climate (Photo 3). The sampled plot was set up with the scale of 11 × 25 m triplicatedly and the sampled sago palms including spineless (*Metroxylon sagu*) and spine (unknown) types on alluvial soil (Fluvisol) with no peat horizon in lowland (water-logging) and upland (high ground water but not water-logging) condition were 3–8 years old by the estimation of counting the scars. The farmers have cut the suckers to keep the palms at minimum, so that there were few sago palms with stem of less than 10 cm in diameter.

Materials and Methods

1. Population density

The number of sago palms having pseudostem of more than 5 cm in diameter at the breast height was counted to calculate the density of sago palms in Alubijid. On the other hand the clumps having the

stem or pseudostem of more than 5 cm in diameter at the breast height were counted in Dalat and Tobimeita.

2. Palm height

The palm height was measured using a measuring pole (FT type of Measuring Pole (15 m), Senshin Industry Co. Ltd.), measured from the base of the counted palm to the top of the highest leaf.

3. Diameter

The girth or circumference of the counted palms was measured by taking the girth size at base level. The diameter was taken by dividing the circumference with 3.1416.

4. Number of living leaves

The number of living leaves was determined by counting the number of remaining leaves in a single counted palm.

5. Statistical analysis

The frequency distribution of palm height with 100 cm interval was calculated using the data taken from Alubijid. The student t-test for the mean difference among three plots in Alubijid was carried out to analyze the results of sago palm growth.

Results

I. Growth indicators of sago palm in Alubijid, Mindanao, Philippines

1. Growth of sago palm

Table 1 shows the population density, the mean plant height, the diameter of sago palm at the ground level, and the number of leaves of sago palm from the different plots in Alubijid, Misamis Oriental, Mindanao, which were determined in 1998 and 1999. Total number of sago palms were 121–152/400 m^2 in 1998 and 153–184/400 m^2 in 1999. The population of sago palms was characterized by the high density in Alubijid which was 3025, 3700 and 3800 palms per ha in 1998 and 4600, 3950 and 3825 palms per ha in 1999. The population density of sago palm remarkably increased as the results of farmer's management. The highest mean palm height of 690 ± 175 cm was found in Plot 3 and the lowest of 627 ± 220 cm was in Plot 1 in 1998 (Table 1). After a year, the mean palm height of the experimental plot was 856 cm (Plot 2), 808cm (Plot 3) and 777cm (Plot 1), respectively, suggesting that there was more than 150 cm elongation per year without Plot 3. The highest mean diameter of 31.7 cm in 1998 was found in

Table 1 The height, diameter at ground level and the number of living leaves of sago palms in Alubijid, Misamis Oriental, Mindanao in 1998 and 1999.

Quadrate	Total number of palms	Height			Diameter			Number of living leaves		
	No (400 m^2) $^{-1}$	Mean (cm)	SD	CV	Mean (cm)	SD	CV	Mean (cm)	SD	CV
					1998					
Plot 1	121	627	220	0.35	31.7	13.4	0.42	5.1	1.9	0.37
Plot 2	148	683	129	0.19	28.3	12.7	0.44	6.0	1.3	0.22
Plot 3	152	690	175	0.25	24.8	9.3	0.38	6.3	1.7	0.26
					1999					
Plot 1	153	777	198	0.25	25.7	9.1	0.35	5.5	1.2	0.22
Plot 2	158	856	162	0.19	28.1	8.7	0.31	5.6	1.1	0.19
Plot 3	184	808	203	0.25	26.8	11.1	0.42	5.7	1.3	0.22

SD: Standard deviation (1998: Plot 1; n = 121, Plot 2; n = 148, Plot 3; n = 152)
(1999: Plot 1; n = 184, Plot 2; n = 158, Plot 3; n = 153)

CV: Coefficient of variation

Plot 1 and the lowest of 24.8 cm was in Plot 3. While in 1999 the highest mean diameter of 28.1 cm was in Plot 2 and the lowest of 25.7 cm was in Plot 1. The fact of the mean diameter suggested that small amount of change in the diameter was observed in the experimental plots of sago palm by the cutting of leaves to make the thatch. The mean number of living leaves was from 5.1 to 6.3 in 1998, and from 5.5 to 5.7 in 1999. These results showed almost the same number of living leaves and indicated the farmer's management for cutting the sago leaves every 3 months.

2. Frequency distribution and t-test for the difference of the mean value of sago palm growth indicators

The frequency distribution of palm height among three plots in Alubijid in 1999 is shown in Fig. 2. This showed no deviation in distribution. Among three plots there was a difference in mean palm height between the data in 1998 and 1999 (Figure 3A). However, the mean palm diameter at the ground level of Plot 2 and 3 showed no significant difference between 1998 and 1999, while Plot 1 showed significant mean difference among the palm diameter at the ground level (Fig. 3B). As far as the number of leaves is concerned, Plot 1 and 2 significantly showed no difference, while Plot 3 showed a significant difference among the means between 1998 and 1999 (Fig. 3C). It is noted that sago palm grows under the management of cutting of leaves every 3 months. The t-test for the difference of the mean values of the height, diameter at the ground level and number of living leaves of sago palm in Alubijid between the results in 1998 and 1999 indicated that the farmer has cut the living leaves every 3 months and remained at least 3 living leaves.

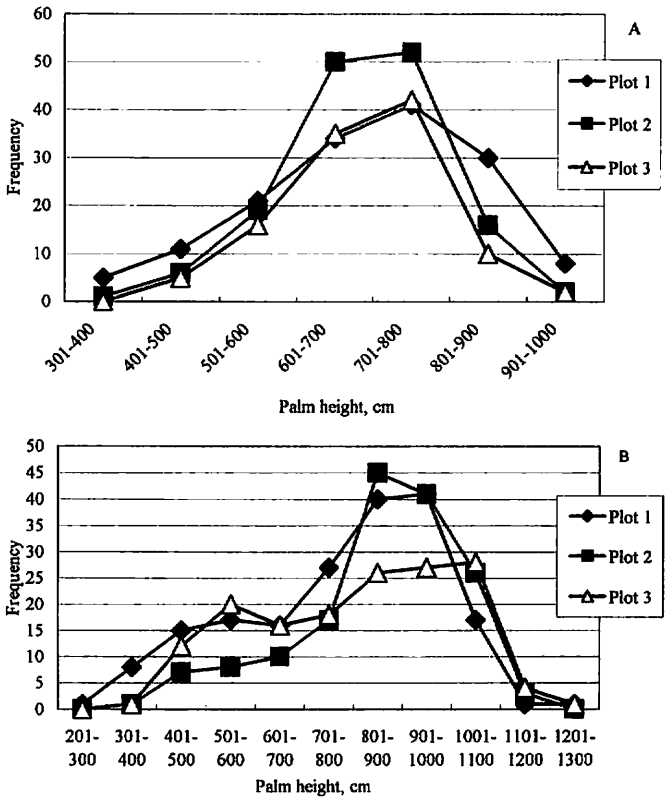

Fig. 2 Frequency distribution of different palm height per plot in Ajubijid in 1998 (A) and 1999 (B).

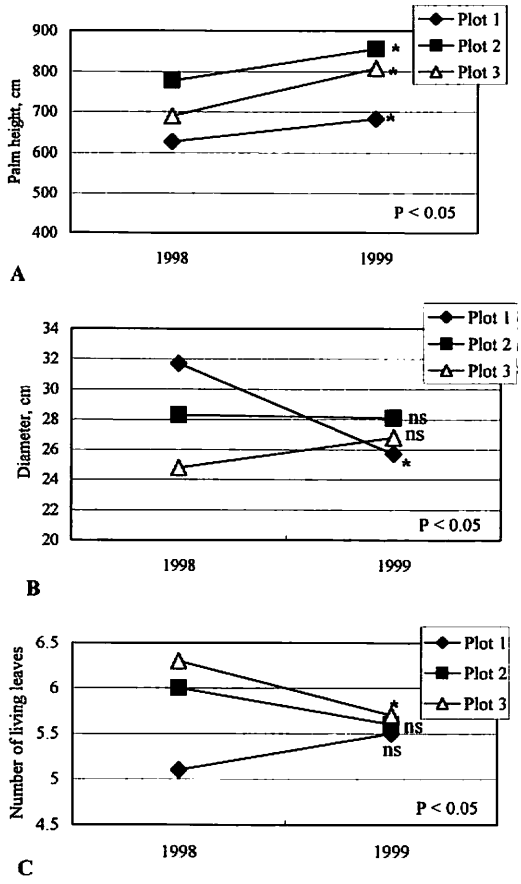

Fig. 3 Mean difference (t-test) of height (A), diameter at ground level (B) and number of living leaves (C) of sago palm in Alubijid between the results in 1998 and 1999.

II. Growth indicators of sago palm in Dalat, Sarawak, Malaysia

Table 2 shows the data on the different growth stages of the same sago palm grown on deep peat soil and shallow peat soil in Balan of Sarawak. Sago palms grown on deep peat soils were sampled at 8, 11 and 12 years after planting. While sago palms grown on shallow peat soil were sampled at 6–10 years. The lowest mean height of 864 cm and highest mean height of 1450 cm were found in 8 and 12 years sago palm on deep peat soil, respectively. On shallow peat soil sago palm showed higher mean height than those on deep peat soil. The highest mean diameter of sago palms at the ground level on deep peat soil was observed in 8 year old palm with a value of 49.7 cm, while the lowest was in 12 years old palms with a corresponding value of 46.3 cm. On the other hand 10 year old palms grown on shallow peat soil have obtained a mean diameter of 58.8 cm at the ground level. The number of living leaves of 11 and 12 years old palms grown on deep peat soil obtained the same value of 9.5, while 8 years old palms obtained a value of 7.5. On the other hand 10 years old palms grown on shallow peat soil have obtained a mean value of 19 living leaves.

The growth of the different sago palm groups with different stages from 4 years to 12 years after planting on deep peat soil in Dalat, Sungai Talau Peat Research Station is shown in Table 2. There were some exceptions in the mean palm height and the mean diameter because of field measurement. The palm height, the diameter and the number of living leaves of 12 years old sago palms before flowering showed 1450 cm, 50.1 cm and 10.2, respectively. The results of 4–5 years sago palms in STPRS shown in Table 2 differed from Table 1 in Alubijid and suggested the different farmer's cultural management.

III. Growth indicators of sago palm in Tobimeita, Sulawesi, Indonesia

Table 3 shows the different growth stages of spine and spineless sago palms in the upland of Tobimeita, Kendari, Sulawesi, Indonesia in 1995. The spineless sago palms were sampled at 3 to 11 years. Although there was an insufficient or incomplete set of data to fully accomplish the comparison, 909 palms per ha, which was 1/3 of the population density in Alubijid, was determined in Tobimeita. Eleven years old sago palm had the highest height value of 1982 cm in Tobimeita. The largest mean diameter at ground level in upland was observed in 8 years old spineless sago palms. There was no significant difference of growth indicators between lowland and upland condition, although it was not enough number of sago palms.

Discussion

The population density of sago palm in Alubijid of Mindanao was extremely higher than those in Dalat of Sarawak and Tobimeita of Sulawesi. The farmers in Alubijid have made few control of the number of

Table 2 Height, diameter at ground level and the number of living leaves of sago palm in Dalat of Sarawak from 1992 to 1997.

	Height		Diameter at the ground level		Number of leaves	
	Mean cm	SD	Mean cm	SD	Mean cm	SD
Balan Deep peat						
8 years	864	28	49.7	1.9	7.5	1.3
11	1171	51	48.1	3.2	9.5	2.0
12	1450	36	46.3	2.6	9.5	1.2
Shallow peat						
6 years	1165	37	57.1	3.0	10.1	2.8
7	1545	50	71.4	2.6	14.1	3.3
8	1688	28	70.2	4.8	17.1	1.9
9	1735	42	68.3	4.2	16.2	2.7
10	1901	52	58.8	4.1	19.0	3.2
STPRS Deep peat						
4 years	442	42	42.9	4.1	15.0	2.1
5	501	35	51.0	4.2	12.2	1.5
6	860	40	56.6	3.8	10.0	1.8
7	757	30	52.0	2.5	10.1	0.7
8	1061	25	51.0	1.6	10.2	1.8
9	1350	38	58.8	1.1	11.0	2.0
10	1370	31	59.3	2.3	11.0	1.5
11	1350	43	53.0	4.6	10.5	1.2
12	1450	42	50.1	4.5	10.2	0.8

SD: Standard deviation STPRS: Sungai Talau Peat Research Station years: after planting

sago suckers and managed to take the sago palm living leaves for the thatch. The formation of sago stem in Alubijid (alluvial soils) was not observed, compared to those in the sago starch production areas such as Dalat (tropical peat soils) and Tobimeita (alluvial soils). The farmers in Alubijid have made few control of the sucker numbers to grow the leader palm in the cluster and taken the sago living leaves and remained at least upper three or four leaves to produce the thatch every three months.

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Table 3 Height, diameter at ground level and the number of living leaves of sago palm in Tobimeita of Sulawesi in 1995.

	Height		Diameter at the ground level		Number of leaves	
	Mean cm	SD	Mean cm	SD	Mean cm	SD
Upland, spineless						
3 years	1002	45	47.3	2.8	14.2	1.1
6	1601	41	61.8	2.1	15.1	0.9
8	1573	32	68.3	3.8	22.0	1.3
9–10	1800	48	60.1	4.2	18.7	2.1
11	1982	38	55.9	2.7	18.8	2.8
Upland, spine						
7 years	—	—	64.3	2.6	20.1	1.8
9	—	—	—	—	19.3	2.1
11	—	—	63.7	4.1	22.8	3.2
Lowland, spineless						
5 years	1320	54	50.2	4.0	14.3	2.3
6–7	1540	52	56.6	3.6	15.4	2.6
8–9	1620	31	51.3	4.2	15.7	0.8
11	1729	47	62.4	5.1	16.3	2.9

SD: Standard deviation
Upland: High ground water but not water-logged
Lowland: Water-logged condition
Years: after planting (estimated)

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