

Characteristics of Seed and Germination of Wild-Type Sago “Manno” (*Metroxylon sagu* Rottb.) Collected from Sago Palm Field around Lake Sentani near Jayapura, Indonesia

Fransiscus Suramas Rembon*¹, Yulius Barra Pasolon¹ and Yoshinori Yamamoto²

¹ Faculty of Agriculture, Haluoleo University, Kendari, Southeast Sulawesi 93232, Indonesia

² Faculty of Agriculture, Kochi University, Nankoku, Kochi 783-8502, Japan

Abstract: Seeds of folk varieties, *Manno Kecil* (Small *Manno*; MK) and both *Manno Besar* (Big *Manno*; MB) and MK were respectively collected in September 2005 (Exp. 1) in Yabaso village and in September 2006 (Exp. 2) in Yabaso and Kehiran villages, District of Sentani, Jayapura, Papua Province, Indonesia. The collected fruit weight of MK and MB ranged from 7.4 g to 44.6 g and 31.8 g to 46.2 g, with an average of 28.2 g and 37.6 g, respectively. The seed weight of MK and MB ranged from 5.8 g to 31.9 g and 21.7 g to 32.9 g, with an average of 20.4 g and 28.0 g, respectively. Fruit weight of both MK and MB was lower than that of the reported cultivated type of sago palms. The germination percentage of MK and MB was 70.1% and 77.3%, respectively, showing a slightly higher percentage in MB than in MK. These percentages were higher than those of the reported cultivated type of sago palms (40-60%). The seed germination of MK occurred from 6 to 69 days after sowing (DAS), showing a rapid increase (ca. 68%) from 20-34 DAS. These results suggested earlier and higher germination percentages during the rapid increase period of the wild-type *Manno* than in the cultivated type of sago palms. Further studies should be performed to clarify the effects of seed maturity and seed size or weight in *Manno* on the germination percentage and rate, using the collected fruits (seeds) from the plant.

Key words: Folk variety, *Manno*, Sago palm, Seed germination, Seed weight

インドネシア、パプア州ジャヤプラ近郊のサゴヤシ園で採集した野生型サゴヤシ (*Metroxylon sagu* Rottb.) “Manno” の種子及び発芽特性

Fransiscus Suramas Rembon¹ · Yulius Barra Pasolon¹ · 山本由徳²

¹ Faculty of Agriculture, Haluoleo University, Kendari, Southeast Sulawesi, 93232 Indonesia

² 高知大学農学部 〒783-8502 高知県南国市物部

要約: インドネシア、パプア州ジャヤプラ近郊のスタニ湖畔のサゴヤシ園に生育するサゴヤシ野生型 (folk variety), 小型 *Manno* (MK) と大型 *Manno* (MB) について、2005年 (Exp. 1) にはヤバソ村でMK, 2006年 (Exp.2) にはそれぞれヤバソ村とケヒラン村でMBとMKの落下成熟果実を外観をみながら採集した。採集したMKとMBの果実重は、それぞれ7.4 – 44.6g, 31.8 – 46.2gを示し、平均果実重は28.2gと37.6gであった。MKとMBの種子重〔果実重から外皮 (外果皮と内果皮) と肉質種皮を除いた重さ〕は、それぞれ5.8 – 31.9g, 21.7 – 32.9gを示し、平均種子重は20.4g, 28.0gであった。両 *Manno* 種の果実重は、報告されている栽培型サゴヤシの果実重に比べて軽かった。MKとMBの種子発芽率は、それぞれ70.1%, 77.3%で、MKに比べてMBでやや高かった。これらの *Manno* 種の発芽率は、報告されている栽培型サゴヤシ種 (40 – 60%) に比べて高かった。MKの発芽は、播種後6 – 69

日にかけてみられ、発芽最盛期は、同20–34日目にみられ、この期間に約68%の発芽がみられた。これらの結果は、野生型サゴヤシ種 *Manno* の発芽は、栽培型のサゴヤシ種に比べて早く、また発芽最盛期の発芽割合が高いことを示した。本研究では、落下種子を採集して供試したために、落下後の経過日数や落下した地上部の環境条件が果実重、種子重や種子の発芽歩合、発芽過程に影響を及ぼしたことが推定され、今後、さらに詳細な検討が必要である。

キーワード：果実重、サゴヤシ、種子重、種子発芽、*Manno*、民俗学的変種

Introduction

Sago palm (*Metroxylon sagu* Rottb.) is able to produce many seeds at the top of the stem at the end of life and propagates through seeds (Akuba 2003). According to Flach (1997), a well-developed inflorescence may carry up to 850,000 fruit. On the other hand, Kiew (1977) estimated that the palm can produce 120,960–376,320 flowers on its inflorescence with about 2,500 fruit within the seeds inside. Moreover, according to Jong (1995) sago palms with heavy fruiting can produce about 276,000–864,000 mature flower buds and 2,174–6,675 mature fruit of about 4–5 cm in diameter. The duration of fruit growth from anthesis to last fruit drop is from 19 to 23 months.

In spite of these facts, sago palm is usually propagated by sucker. One of the reasons farmers use the suckers as the propagating material is the shorter duration from planting to harvesting (around the flowering stage) compared with the seedlings. However, as it is very difficult to collect the huge amount of evenly grown and good-quality suckers for a large-scale planting, using seedlings as the propagating material should be considered in such a case. Due to earlier harvesting before seed maturation in sago palms, few reports are available on the characteristics of seed germination (Jong 1991, Ehara et al. 1998, 2001) because of the difficulty of collecting the seeds. It might be very important to clarify the characteristics of seed germination of the sago palm when using seeds as the propagating material in large-scale planting.

The authors have recognized many types of sago palms (folk varieties, i.e., varieties classified by local people) around Lake Sentani near Jayapura, Papua Province, Indonesia, and have been conducting

research on the differences in the growth characteristics and the starch productivity of these sago palms (Yamamoto et al. 2006). During this research, it became clear that the local people recognized the wild-type sago palm (“sago hutan”), *Manno*, as characterized by low starch productivity, and therefore usually not harvested by the people. *Manno* was classified into two types by the plant size, i.e., big *Manno* (“*Manno besar*”) and small *Manno* (“*Manno kecil*”). Around the bolting stage, large and small *Manno* showed respective trunk weights of about 1230 kg and 440 kg (Yanagidate et al. 2007). It is easy to collect the seeds of these sago palms due to less frequent harvesting.

This research was performed to study the germination characteristics of the sago palm using the seeds of *Manno* which are easy to collect, in order to gain the basic data for the establishment of the propagation method in large-scale planting.

Materials and Methods

Two experiments were performed in two consecutive years, experiment 1 in 2005 and experiment 2 in 2006.

Experiment 1

Fifty-eight fallen mature sago fruit with good appearance were randomly collected in September 2005 under the fruiting sago palm tree of small *Manno* (MK, spiny-type) in Yabaso village around Lake Sentani, District of Sentani, Jayapura. After each fruit was weighed using an electronic balance, the husk (exocarp and mesocarp) and sarcotesta were removed by washing with tap water (Fig. 1), and the seeds were weighed following the same method for the fruit weight. The treated seeds were then sown at 1 cm depth

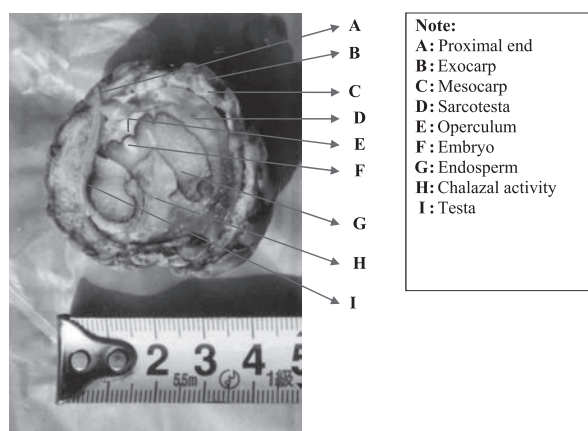


Fig. 1. Cross-sectional view of sago palm fruit. Husk (exocarp and mesocarp) and sarcotesta were removed before sowing in the experiments.

from the surface of the seed bed (44 cm x 34 cm x 20 cm) which was filled with the mixture of an organic fertilizer called Multi Organic Fermented Fertilizer (MOF) and sand 1 : 1 (v/v). The MOF was a compost of wasted sago extract: mineral soil : sawdust : chicken manure, 6:1:2:2 (v/v), respectively. The germination medium was 10 cm in depth and was watered daily in order to maintain a humidity close to the natural environmental condition in the field. The reason of using a mixture of MOF and sand is to increase water holding capacity of the seed bed medium.

Germination counts were made during the experiment up to three months after seeding. The seed is considered as germinated when the epiblast or shoot and

the primary root have emerged (Ehara et al. 1998). Accumulated percentage of seed germination was calculated by dividing the number of germinated seeds on the observed day by the total germinated seeds until the final observed day.

Experiment 2

The fallen mature sago fruit with good appearance of small *Manno* (MK) and big *Manno* (MB, spiny-type) were randomly collected in Kehiran and Yabaso villages, respectively. Among the collected fruit, 29 and 46 were measured for the fruit and seed weight, respectively, following the same method as in experiment 1. The fruit sizes were also measured for diameter and longitudinal length using a caliper.

Germination counts were made until 3 months after sowing when no more germinated seeds appeared, following the same method as in experiment 1, although no record of the germinated number of seeds was made on each observed day. Percentage of germination was calculated by dividing the final number of germinated seeds by the total sown seeds.

Results

Experiment 1

The collected fruit weight of MK ranged from 7.4 to 44.6 g with an average of 25.4 g (Table 1). The seed weight ranged from 5.8 to 31.9 g with an average of

Table 1. The average seed, husk (exocarp and mesocarp) +sarcotesta and fruit weights of small and big *Manno*, experiments 1 and 2.

Folk variety	Item	Seed weight (g)	Husk+sarcotesta ¹⁾ (g)	Fruits weight (g)	Fresh seeds and fruits weight ratio (%)
Small <i>Manno</i> (Exp. 1)	Average ± SE	19.2 ± 1.3	6.2 ± 0.6	25.4 ± 1.9	75.6
	Maximum	31.9	12.6	44.6	
	Minimum	5.8	1.6	7.4	
	Range	26.1	11	37.2	
	CV (%)	26.8	36.5	29	
Small <i>Manno</i> (Exp. 2)	Average ± SE	21.5 ± 1.4	9.4 ± 5.1	30.9 ± 2.5	69.6
	Maximum	27.6	17.2	37.3	
	Minimum	13.7	0.9	21.8	
	Range	13.9	16.3	15.5	
	CV (%)	14.9	56.7	15.6	
Big <i>Manno</i> (Exp. 2)	Average ± SE	28.0 ± 1.5	8.6 ± 4.3	37.6 ± 1.9	74.5
	Maximum	32.9	15.5	46.2	
	Minimum	21.7	2.6	31.8	
	Range	11.2	12.9	14.4	
	CV (%)	11.8	49.7	10.1	

Data followed by ± indicated the value of standard error. CV = coefficient of variation. 1) Husk indicates exocarp and mesocarp of fruit.

19.2 g. The highest frequency of seed weight was observed at 25-26 g, followed by 18-19 and 19-20 g (Fig. 2). The frequencies of seed weight 11 g > and 26 g < were few. The calculated seed/fruit weight percentage was 75.6%. The coefficients of variance (CVs) (%) of the fruit and seeds were almost the same, 29% and 27%, respectively, and these CV values were lower than that of the husk + sarcotesta (36.5%).

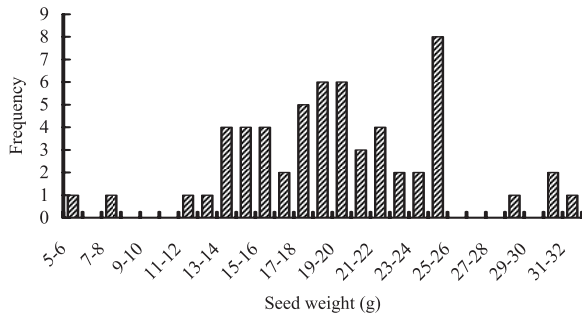


Fig. 2. Distribution of the seed weights of small *Manno* (Experiment 1)

The accumulated percentage of seed germination is shown in Fig. 3. The seed germination occurred from 6 to 69 days after sowing (DAS) and showed a remarkable increase from 20 to 34 DAS (ca. 68.3%). Before and after this period, the germination rate was not as high. The final germination percentage was 70.7%.

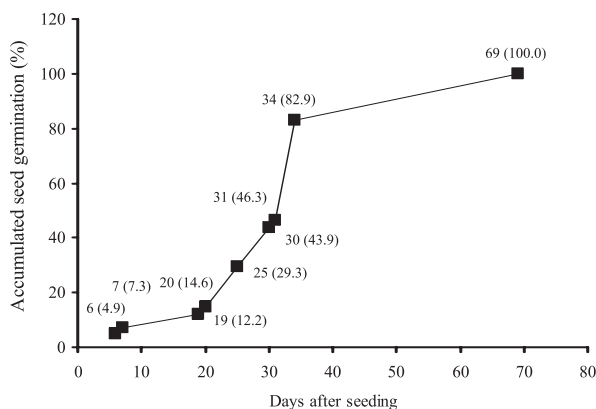


Fig. 3. Accumulated percentage of seed germination of small *Manno* (Experiment 1). Numerals in the figure indicate days after sowing (accumulated germination %).

Two types of seedlings, spiny and non-spiny types, were observed from the seeds collected simultaneously (Fig. 4), although these seeds were



Fig. 4. Spiny (left) and non-spiny (right) seedlings of germinated small *Manno* observed in experiment 1. Photos were taken at 8 months after transplanting into plastic bags.

collected under spiny mother palms. The ratio of spiny- and non-spiny-type seedlings was 43.9% : 56.1%.

Experiment 2

The collected fruit weights of MK and MB ranged from 21.8 to 37.3 g, and from 31.8 to 46.2 g, with an average of 30.9 and 37.6 g, respectively (Table 1). The average fruit diameter and longitudinal length were 3.54 and 3.37 cm for MK and 3.70 and 3.62 cm for MB, respectively. The seed weights of MK and MB ranged from 13.7 to 27.6 g, and from 21.7 to 32.9 g, with an average of 21.5 and 28.0 g, respectively. The average weights of fruit and seeds were 18% and 24% higher in MB than in MK, respectively. The CVs (%) of fruit and seeds were 15.6% and 14.9% for MK and 10.1% and 11.8% for MB, respectively. These CV values were smaller than those of the husk + sarcotesta (50-57%). The calculated seed/fruit weight percentages of MK and MB were 70 and 75%, respectively.

The germination percentages of MK and MB were 69.4% and 77.3%, respectively, showing a slightly higher percentage in MB compared with MK.

Discussion

The average weights of fruit and seeds of MK in experiments 1 and 2 were 28.2 g and 20.4 g, respectively, and these values were 25% and 27% lower than those of MB in experiment 2 (fruit wt: 37.6 g; seed wt: 28.0 g), respectively. The fruit weight of wild-type *Manno* was lower than that of the

cultivated type, 42.0-48.0 g, collected at Batu Pahat, Johor, Malaysia (Ehara et al. 2001). Although the weights of fruit and seeds of the sago palm might be determined by the genetic background, number of fruit per flower stalk, ripening degree, etc., the results of this research showed that the fruit and seed weights of the wild type were lower than those of the cultivated type, and were lower in MK with a smaller plant size than in MB with a larger plant size (Yanagidate et al. 2007).

The fallen fruit collected under the matured palm were used as the experimental material in this research, so the decomposition of fruit exterior (husk) might have proceeded to some extent and the weight of the husk become lighter. This fact was observed in the higher differences of husk + sarcotesta weight in MK compared with the seed weights between experiments 1 and 2. Moreover, in experiment 2, the difference in husk + sarcotesta weight was smaller than that of seed weight between MK and MB.

To promote the seed germination, the husk and sarcotesta were removed before sowing in this research, in consideration of previous studies (Alang and Krishnapillay 1986, Jong 1991, 1995, Ehara et al. 1998, 2001). The average of germination percentage of MK in experiments 1 and 2 was 70.3%, and that of MB in experiment 2 was 77.3%. These germination percentages were higher than those of the cultivated type of sago palm performed in the germination test after the same treatment to the fruit, 40-60% and 40-50%, collected at Dalat, Sarawak (Jong 1995) and Batu Pahat, Johor, Malaysia (Ehara et al. 1998), respectively.

Spiny- and non-spiny-type seedlings were observed in the germinated seeds of MK in experiment 1. This result indicated that cross-pollination might have occurred (Flach 1977, Alang and Khrisnapillay 1986). It was suggested that fertile fruit were only found where two or more fruiting sago palms were in close proximity to each other, and proved that sago palm is an obligatory cross-pollinator.

The result of change in seed germination after

sowing in MK indicated that the germination occurred from 6 to 69 DAS, showing a rapid increase (ca. 68%) from 20 to 34 DAS. Ehara et al. (2001) reported that the germination of cultivated sago palm seeds, treated in the same way as in this research, under 30°C water condition occurred from 32 to 80 DAS, showing a rapid increase (ca. 50%) from 32 to 48 DAS. Comparing the results, it was suggested that earlier germination and higher germination percentages occurred during the rapid increase period of the wild-type *Manno* than in the cultivated type of sago palm. The differences might be based on the different methods of fruit (seed) collection and the germination test, as well as genetic differences.

The results mentioned above revealed that in two types of wild sago palm, growing around Lake Sentani near Jayapura, Papua, Indonesia, the fruit and seed weights were greater in MB with larger plant size compared with MK with smaller plant size, and the germination percentage of *Manno* was higher than that of the cultivated type in Malaysia, although the fruit weight was less in *Manno*.

Using the fallen fruit (seeds) for the experimental material in this research might have influenced the germination rate and percentage as well as the fruit and seed weights of *Manno* through the period from the falling to the collecting of fruit and the environmental conditions on the ground where the fruit fell. For example, the germination inhibitors contained in the pericarp (exocarp and mesocarp) of fruit (Ehara et al. 2001) may leach out during rain. Further studies should be performed to clarify the effects of seed maturity and seed size or weight in *Manno* on the germination percentage and rate, using the collected fruit (seeds) from the plant. Comparison of the germination inhibitors between the sago fruit belonging to different folk varieties is also necessary.

References

Alang, Z. C. and B. Krishnapillay 1986 Studies on the growth and development of embryos of the sago palm (*Metroxylon* spp.) in vivo and in vitro. *In*: The

- third International Sago Symposium SAGO-'85: Protect mankind from hunger and the earth from devastation. (Yamada, N. and K. Kainuma eds.) Proceeding of the Third Int. Sago Symposium, 20-23 May, 1985. Tokyo, Japan, pp. 121-129.
- Akuba, A. H. 2003 Sago palm (*Metroxylon sagu* Rottb.) genetic conservation in Indonesia: Status, problems and prospects. *In: Sagu Untuk Ketahanan Pangan.* (Akuba, R. H., Z. Mahmud, E. Karmawati, A. A. Lolong and A. Lay eds.) Proceedings of National Sago Seminar in Manado 6 October 2003, pp. 20-33.
- Ehara, H., C. Komada and O. Morita 1998 Germination characteristics of sago palm seeds and spine emergence in seedlings produced from spineless palm seeds. *Principes* 42: 212-217.
- Ehara, H., O. Morita, C. Komada and M. Goto 2001 Effect of physical treatment and presence of the pericarp and sarcotesta on seed germination in sago palm (*Metroxylon sagu* Rottb.). *Seed Science and Technology* 29: 83-90.
- Ehara, H. 2002 Major factors limiting seed germination of sago palm (*Metroxylon sagu* Rottb.). *In: New Frontiers of Sago Palm Studies.* (K. Kainuma, M. Okazaki, Y. Toyoda, and J. E. Cecil eds.) Universal Academy Press, Inc. (Tokyo) 271-274.
- Flach, M. 1977 Yield potential of the sago palm and its realization. *In: The first International Sago Symposium.* (Koonlin, T. ed.) 5-7 July 1976, Kuching Serawak, Malaysia, pp. 157-177.
- Flach, M. 1997 Promoting the conservation and use of underutilized and neglected crops. 13. Sago Palm (*Metroxylon sagu* Rottb.). International Plant Genetic Resources Institute, Rome, Italy, pp. 76.
- Jong, F. S. 1991 Studies on the seed germination of sago palm (*Metroxylon sagu* Rottb.). *Proc. of the Fourth Int. Sago Symposium, Kuching, Sarawak, Malaysia, 6-9 August, 1990, pp. 88-93.*
- Jong, F. S. 1995 Research for development of sago palm (*Metroxylon sagu* Rottb.) cultivation in Sarawak, Malaysia. Sadong Press. Sdn. Bhd., pp. 139.
- Kiew, R. 1977 Taxonomy, ecology and biology of sago palms in Malaya and Sarawak. *In: The first International Sago Symposium.* (Koonlin, T. ed.) 5-7 July 1976, Kuching Serawak, Malaysia, pp. 147-154.
- Yamamoto, Y., T. Yoshida, A. Miyazaki, F. S. Jong, Y. B. Pasolon and H. Matanubun 2006 Biodiversity and productivity of several sago palm varieties in Indonesia. *In: Sago Palm Development and Utilization* (Karafir, Y. P., F. S. Jong, and V. E. Fere eds.). Proceedings of the 8th International Sago Symposium, August 4-6, 2005. Universitas Negeri Papua, pp. 35-40.
- Yanagidate, I., Y. Yamamoto, T. Yoshida, A. Miyazaki, Y. B. Pasolon, S. Darmawanto, J. L. Limbongan, F. S. Jong, A. F. Irawan and F. S. Rembon 2007 Characteristics of growth and starch productivity of so-called wild type sago palm "Manno" grown near Jayapura, Papua Province, Indonesia, Abstract of the 16th Conference of the Society of Sago Palm Studies, pp. 8-11. (in Japanese)