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To cite this article: A Hani *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **914** 012033

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The initial growth of *tacca* (*Tacca leontopetaloides*) as food crops in the agroforestry pattern with *malapari*

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Abstract. Indonesia has many types of carbohydrate sources. *Tacca* (*Tacca leontopetaloides*) has potential as a source of the functional food industry, especially maltotriose and maltotetraose production. *Tacca* grows well in an open or a shaded area on sandy soil-mineral, soil pH is slightly alkaline, with very low to low Cation Exchange Capacity. *Malapari* (*Pongamia pinnata*) is a biofuel-producing plant with a natural distribution on coastal land. Planting combination between *malapari* as an energy-producing plant and *tacca* as a food source has never existed. So, it needs to be incentives in developing agroforestry that can provide intermediate results for farmers. The requirement of good quality *tacca* seedlings is a crucial factor in supporting food security. This study aimed to determine the effect of the types of *tacca* seeds used on the initial growth of *tacca*. The study used a randomized complete block design consisting of 3 (three) treatments: a) large tubers, b) small tubers, and c) the origin of seeds. The results showed that plants from large tubers produced the highest number of shoots, height, and diameter (5.83; 27.77 cm and 0.43 cm). Five years old *malapari* reaches a diameter of 6.95 cm, a height of 3.89 m, and a crown width of 2.43 m.

1. Introduction

Indonesia has many types of carbohydrate sources. Carbohydrate is one of the basic needs of the Indonesian people. *Tacca* can be a source of the functional food industry, especially maltotriose and maltotetraose production [1]. *Tacca* contains sufficient carbohydrates to replace rice and wheat and is recommended for consumption by diabetics [2]. The tuber of *tacca* contained: 2.67-2.71 % of ash; 6.73-7.84 % of protein; 0.43-1.90 % of fat; 0.41-0.60 % of crude fibre; 77.09-82.65 % of carbohydrate and available energy 352.36-365.83 Kcal 100g⁻¹ based on dry weight, 173.50-173.67 mg 100g⁻¹ of magnesium; 4.00-8.69 mg 100g⁻¹ of iron; 69.89-87.72 mg 100g⁻¹ of calcium; 904.86-966.74 mg 100g⁻¹ of potassium; and 222.59-270.46 mg 100g⁻¹ of phosphor [3]. Even though *tacca* has cyanogenic glycoside content over 43 mg/kg [4], this plant can still be consumed like cassava that has cyanogenic content of 10-500 mg kg⁻¹ [5]. Processing methods can detoxify cyanogenic glycosides and reduce the risk of cyanide poisoning. However, the efficiency of cyanide removal depends on the processing technique employed and the extent of processing. The processing operations such as fermentation, boiling/cooking, and drying applied to process food containing cyanogenic glycosides have been reported to reduce cyanide content to acceptably safe levels. *Tacca* grows in an open or a shaded area on sandy soil-mineral, soil pH is slightly alkaline, Cation Exchange Capacity is very low to low [6]. It is a source of carbohydrate that is very potential to be developed in small islands in dealing with



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climate change [7]. *Malapari* (*Pongamia pinnata*) is the legume family that has a growing distribution in the coastal area such as in Sumatra, Java, Kalimantan, West Nusa Tenggara, Papua and Maluku [8]. *Malapari* seeds can be used for biofuels because they contain 30-40% oil [9].

Indonesia, as an archipelago, also has potential plants as a source of biofuel energy. *Malapari* seeds contain oleic and linoleic fatty acids, which are the active ingredients for making biodiesel [9]. The leguminous tree pongamia (*Pongamia pinnata* syn. *Milettia pinnata* L.) could be utilized to produce biofuel while restoring degraded land [10]. However, the combination of planting between *malapari* as an energy-producing plant and *Tacca* as a food source on the agroforestry system has never existed. The planting of biofuel-producing in Purworejo has not been attractive to farmers, so lack of maintenance. So, it needs to be incentives in developing agroforestry that can provide intermediate results for farmers. One effort to overcome the limiting factors of cultivation on coastal land is through an agroforestry system. If the agroforestry system on coastal land is an innovation, so its adoption by the community is important. The first thing to do for this agroforestry system is to supply good quality *Tacca* seedling. This study aims to determine the initial growth of *Tacca* under *malapari* stands.

2. Materials and Methods

2.1. Time and location

In 2016 Forest Research and Development Agency (FORDA) had planted *malapari* in the coastal area. The *tacca* was planted in January 2021. This activity is carried out at the village self-sufficiency energy (ESV) or "Mandiri Energy Village (DME) in Patutreja village, Purworejo District, Central Java.

2.2. Materials and tools

The materials used in this study were: 5-year-old *malapari* plant, *Tacca* tubers from exploration in 3 locations (Karimunjawa Islands & Seribu Islands), organic fertilizers. The tools used are hoes, machetes, measuring instruments for height and diameter, buckets, scales, and stationery.

2.3. Research design

This study used a randomized completely block design. The treatments tested were three types of *tacca* tubers: small tubers (<400 g), large tubers (>400 g), and seed origin. Each size of tubers was planted with 30 tubers repeated three replications so that the total tubers used were 270 tubers. *Tacca* tubers are planted at a spacing of 1 x 1 m. Tuber observer parameters were the number of shoots, shoot diameter and shoot height. The annual trees in the research location are *malapari* and coconut (*Cocos nucifera*). The *malapari* plant was planted in 2016, with 5 x 5 m spacing planting. The coconut is a community-owned plant that has been around for a long time with a spacing of 6 x 11 m. The *malapari* and coconut plants in the observation plot were observed for height, diameter, and crown width.

2.4. Data analysis

The data from the measurement results were analyzed using diversity analysis assisted by using the SPSS version 26 program. If there is a significant difference, then continue with Duncan's continued test.

3. Results and Discussion

The annual plants in the research location are coconut and *malapari*. Coconut is widely cultivated by people along the southern coast of Java Island because it is suitable with the conditions where it grows in the sandy soil. *Malapari* is also a species that naturally grows in sandy coastal forests. The growth of *malapari* and coconut plants at the research location is presented in Table 1.

Table 1. Growth of coconut and *malapari* at 5 years old.

Annual Plant	Diameter (cm)	Height (m)	Crown Width
Coconut	29.4	9.00	5.56
<i>Malapari</i>	6.95	3.89	2.43

Coconut is used to meet the daily needs of the community. The advantage of coconut is easy to cultivate and does not require intensive care. Products from coconut are generally taken from old fruit or young fruit suitable to market needs. In addition, some people take sap water to be processed into sugar every day. If the coconut sap water is taken, it will not produce coconuts. Coconut has a light crown and a wide spacing (6 m x 11 m) so that in the area under the coconut tree is still possible to plant various types of understorey. Coconut agroforestry with a mixed cropping pattern will maximize land productivity while increasing the income of coconut farmers [11]. Root crops such as taro are better to plan under coconut trees than monoculture since they increase the economic value of the land [12]. *Malapari* is resistant to extreme drought, nitrogen deficiency, and strong winds [13]. Therefore, it is suitable as a windbreak plant on agroforestry systems and nitrogen fixer in sandy coastal areas. *Malapari* agroforestry with *tacca* is expected to increase the productivity of sandy coastal land. The initial growth of *tacca* plants based on the type of plant material used is presented in Table 2.

Table 2. Analysis of variance results in the influence of types of planting materials.

Source of Variance	Sum of square	df	Mean square	F cal.	Sig.
Number of shoot	677.78	2	338.89	46.26	0.00*
Block	104.91	2	52.46	7.16	0.00
Height	51014.49	2	25507.25	233.96	0.00*
Block	433.41	2	216.71	1.99	0.14
Diameter	13.85	2	6.93	41.95	0.00*
Block	2.23	2	0.11	0.70	0.50

Table 2 shows that the planting material used in planting *tacca* tubers will affect the quality of the plant's growth. The different types of planting material bring significant differences among the treatment in the number of shoots, height, and diameter. The best treatment of the results of Duncan's further test is presented in Table 3.

Table 3. Duncan's test effects of types of planting materials.

Treatment	Number of shoot	Height (cm)	Diameter (cm)
Big tuber	5.83 a	27.77 a	0.43a
Small tuber	4.40 b	25.58 b	0.32b
Seeds	1.91 c	5.08 c	0.05c

Table 3 shows that planting material from large tubers produced the best growth in all parameters. The larger the tuber size, the greater the food reserves for vegetative growth [14]. A large tuber will produce more buds. It will lead to an increase in photosynthetic activity, which will increase the assimilation of the growth of other vegetative organs [15].

4. Conclusion

The use of large bulbs as material for *tacca* tubers will further increase the success of the planting.

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Acknowledgments

The author would like to thank the Sino-ASEAN Network of Forestry Research Institutes (SANFRI) for financing this research.

Author's contribution

Aditya Hani: conceptualization, methodology, analysis, writing, Ratna Uli Damyanti: conceptualization, writing, project administration, Megawati: writing, review, T Suharti: writing, review Zanzibar: writing, supervision