Morphological characteristics of sugar palm \textit{[Arenga pinnata Merr.]} seedling growth based on cotyledon petiole position

A Sari*, A Anwar, I Dwipa, and D Hervani
Department of Agrotechnology, Agriculture Faculty, Andalas University, Padang, West Sumatera, 25163 Indonesia
Email: afrimasari@agr.unand.ac.id

Abstract. Sugar palm is a bioenergy plant with great potential in food security, biopolymers, biofuel, and herbal medicine. Sugar palm seed germination is indicated by the appearance of cotyledon petiole, where there are several different positions. Morphological characteristics of sugar palm seeds at various positions of cotyledon petiole are not currently available. This research aimed to study the morphology characters of sugar palm seedlings with different cotyledon petiole positions. The research applied Experiment in Completely Random Design with four treatments, each repeated three times. The four treatments are the cotyledon petiole position, namely P1: cotyledon petiole in right-center, P2: cotyledon petiole in left-center, P3: cotyledon petiole in left-bottom, and P4: cotyledon petiole in right-bottom. The results showed that morphologically, there was no significant difference in the sugar palm seedling growth [256 DAS]. Range of seed height 47.63-57.50 cm, range number of leaf midribs 2-3.33, range of primary root length 13.73-21.76 cm and, range of secondary root length 28.60-44.26 cm.

Keywords: cotyledon petiole, growth, morphology, seeds, sugar palm

1. Introduction

\textit{Arenga pinnata} Merr., is a native Indonesian plant that can be a source of food, bioindustry and bioenergy, and nano cellulosic and biofuel materials [1]. Huzaifah et al. [2] reported that palm fibers contain high cellulose and fiber attractiveness and long-lasting. Palm fruit contains antioxidants, flavonoids, alkaloids, and quinones and can be used to treat osteoarthritis empirically [3].

Sugar palm plants can also use as an enrichment crop in post-mining land and become an insert plant [4]. According to Mariati [5], sugar palm plants can adapt to various soil, critical land, and grasslands. Smith [6] states that sugar palm can be planted in different topographies and function as forest conservation in preventing soil erosion because palm sugar roots can reach a depth of about 6 m.

Sugar palm plants need a long time [5-6 years for early variety and 8-10 years for deep varieties] to reach productive age [7]. Sugar palm seeds also experience dormancy, but research on breaking dormancy with various treatments has shortened seeds' dormancy period [8]. In general, farmers only use sugar palm that grows naturally without knowing seed origination derivate. Provision of quality sugar palm seeds, according to Tenda et al. [9], can be obtained through exploration, characterization, selection, and collection activities carried out gradually and sustainably.

The characteristic of the seed germination stage of sugar palm is the variation cotyledon petiole position. Cotyledon petiole is a white spongy tissue that grows shoots and roots, appeared 2-4 weeks after sowing [10]. The effect of cotyledon petiole position on the morphological characteristics of palm seedlings is not currently available. This research can be the first step in identifying a palm seed's
quality by observing the morphological characters at the seedling stage and as a basic science in the next step.

2. Materials and Methods
This research was conducted at the Laboratory of Seed Science and Technology, Faculty of Agriculture, Andalas University. It started in January-December 2020. The sugar palm seeds originated from Nagari Andaleh Baruah Bukik, Sungayang District, Tanah Datar Regency, West Sumatera.

The breaking seed dormancy method was physical scarification by sanding the seed's back using sandpaper. Seeds were then disseminated in wet cotton media and placed in a germinator in the laboratory. After the seeds germinate, they are separated based on the cotyledon petiole position, then transplanted into mixed media [1:1 of soil and manure] in 30cm x 35cm polybags. The research applied Experiment in Completely Random Design with three replications consisting of 25 seeds so that the total seedlings observed were 300 seeds. There are four cotyledon petiole positions in the observed sugar palm seed [Figure 1].

![Figure 1](image1.png)

Figure 1. Position of cotyledon petiole emergence in sugar palm germination process. [P1: Cotyledon petiole in right-center; P2: Cotyledon petiole in left-center; P3: Cotyledon petiole in left-bottom; P4: Cotyledon petiole in right-bottom].

The seedling growth characteristics observation were seed height [cm], the number of leaf midribs, primary root length [cm], and secondary root length [cm] are observed at 256 days after sowing [DAS]. The observations were analyzed using variance at the 5% significance level and, if there was a significant difference, then tested further with DNMRT at the 5% significance level.

3. Results and Discussion

3.1. Germination process of sugar palm
The seed germination process begins with the imbibition process, enzyme reactivation, embryo germination initiation, seedcoat cracking, radicle emergence, and plumule emergence [11]. One of the obstacles to successful germination is seed dormancy. Saleh [12] reported that sugar palm has a reasonably long dormancy period, which is about 4–6 months and sometimes even up to 1 year. Sugar palm has a hard seedcoat [exogenous dormancy], causing it difficult to absorb water [13]. They are overcoming seed dormancy by providing physical, mechanical, and chemical treatments [14]. Scarification and KNO3 can break dormancy and increase the viability and vigor of palm seeds up to 86.67%. The scarification of the seed plumula and KNO3 concentration of 1% came up as the best treatment [15]. The stages of sugar palm germination are shown in Figure 2 below:
Figure 2. The germination stages of sugar palm seed. [a: Sugar palm seed; b: Cotyledon petiole emergence; c: Formation of coleoptile; d: The first leaf recipe; e: First leaf development; f: Sugar palm sprouts with leaves open entirely].

The emergence of cotyledon petiole indicates the success of the seed germination process [Figure 2]. In the next stage, the coleoptile appears above the soil surface, then the first leaf will form, and the first leaf continues to grow until leaves open entirely [98 DAS].

The percentage of sugar palm seeds germination is >90% on the 40th day after harvest. Its figure out that the seeds in this study have high viability. It also proved that the physical scarification has successfully stopped the seed dormancy, initiated the germination. If calculated from the time of harvest, the dormancy fracture time is 40 days. However, it does calculate from sanding; it only takes seven days or one week.

3.2. The seedling growth of sugar palm

The seedling growth data showed no significant effect of differences in cotyledon petiole position with seedling height, several leaf midribs, primary root length, and secondary root length [Table 1 and Figure 3]:

Table 1. The average of height, number of leaf midribs, primary root length, and secondary root length of sugar palm seedlings at the age of 256 DAS from seeds with different positions of cotyledon petiole appearing

| Treatments         | Seed height [cm] | Number of leaf midribs | Primary root length [cm] | Secondary root length [cm] |
|--------------------|------------------|-------------------------|--------------------------|---------------------------|
| P1 [Right-center]  | 57,50            | 3,00                    | 21,76                    | 44,26                     |
| P2 [Left-center]   | 55,40            | 2,67                    | 19,70                    | 37,46                     |
| P3 [Left-bottom]   | 47,63            | 3,33                    | 13,73                    | 28,60                     |
| P4 [Right-bottom]  | 49,33            | 2,00                    | 19,20                    | 28,73                     |

According to the F test, the same column numbers are not significantly different at the 5% significance level.

After transplanting, a coleoptile appeared at 40-46 DAS, which served to protect the plumules. The first leaves appeared above the ground [± 10 cm] in the range 73-78 DAS. cotyledon petiole in the right-center showed the highest average of seed height, primary and secondary root length, was 57,50 cm, 21,76 cm, and 44,26 cm. The highest number of leaf midribs is an average of 3,33 seeds with the cotyledon petiole in the left-bottom. Sugar palm is a slow-growing plant such as leaf midribs, which have an annual increase of only about 3-6 leaves [4].
The criteria for sugar palm seeds that are ready for planting are seedlings aged 12-18 months, have a height of ≥40 cm, the number of leaves ≥, four fully open, and twisted stems ≥10 cm [10]. Sugar palm seedlings transplanted after 8-10 months of age since the first leaves are formed or have 4-5 fully open leaves [16]. In this study, the seeds were ≥8 months the number of leaves up to 3-4 leaves. Different factors can influence so that it is necessary to identify further growth stages and other seed sources.

![Image](image-url)

**Figure 3.** Morphology seedling of sugar palm at 256 DAS. [P1: Cotyledon petiole in right-center; P2: Cotyledon petiole in left-center; P3: Cotyledon petiole in left-bottom; P4: Cotyledon petiole in right-bottom].

**4. Conclusion**
This research concluded that the difference in cotyledon petiole position could not be used as a marker in the sugar palm germination to determine its quality, especially the morphological growth of seedlings, including seed height, number of leaf midribs, primary and secondary root length.

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