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# Germination technique of *Pandanus tectorius* (Park.) seeds

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**Abstract:** *Sea pandanus (Pandanus tectorius Park.) is a living plant whose humans use all parts. This plant has bright prospects to be developed in the future. Ecological benefits as abrasion resistance, wind resistance and tsunami mitigation. The presence of secondary metabolites in pandan fruit and leaves can be used as an ingredient for treatment, and even the leaves can be used in the fibre industry. Propagation of this plant can be done through seeds and cuttings. Cultivation techniques for sea pandanus have been carried out to determine the effect of polybag size and growth media on germination. The success of germination is one of the determinants of plant cultivation success. Sea pandan seeds are recalcitrant seeds, seeds that are difficult to germinate. It is necessary to conduct research related to the acceleration of germination. This study aimed to determine the best soaking time for producing ready-to-plant seeds. This study used a completely randomized design (CRD) with ten replications. Data analysis used the F test, followed by the minor significant difference test (BNT). The duration of soaking fruit/seeds for 1, 2, 3, 4 and 5 days did not differ in germination time. Soaking fruit/seeds for 1, 2, 3, 4 and 5 days showed germination time on days 37, 38, 39, 40 and 41. The seeds' height and root length parameters were not different for all treatments. The treatment of removing part of the fruit mesocarp by soaking for one day can be used for sea pandan seed germination techniques.*
**Keywords:** *Sea pandanus, seed germination, technique*

## I. Introduction

Sea pandan (Pandanus tectorius Park.) is a coastal plant with many functions (ecological, aesthetic, material for weaving, food, and medicine). Ecological functions include tsunami mitigation by forming coastal forests or coastal greenbelts. The mitigation function requires large quantities of sea pandanus plants. Sea pandanus naturally propagates itself through seeds and also through stem cuttings. Propagation of plants through seeds takes a long time. The seeding process begins with soaking in water for five days, and on average, it will germinate after two months of seeding. To get seeds ready to be grown in the field, the total seed production time can reach six months (Hani & Dendang, 2008). The first flowering from seed propagation takes up to 10-25 years, while through stem cuttings, it blooms in the sixth year (Thomson et al., 2006; Gallaher, 2014).

Hani and Dendang studied this sea pandanus seedling technique in 2008. The size of polybags and growing media affect seed quality. Plant propagation by seeds and stem cuttings was studied by Rahayu et al. (2016). The results showed that seedlings from seeds took about six months to grow, while seedlings from stem cuttings took a much shorter time, i.e. 2-3 months. Seeds derived from seeds are abundant in nature, but seeds from stem cuttings will cause problems if taken in large quantities because they will damage the mother plant.

Pandan seeds are recalcitrant and do not germinate quickly. It is necessary to remove the recalcitrant properties of pandan seeds with a more extended immersion than non-recalcitrant seeds. Based on the above background, this research was conducted to find a technique to accelerate the germination process.

This study aimed to obtain a technique for obtaining sea pandan seeds faster in the seed germination process.

## II. Review of Literature

### 2.1 Sea Pandan and Its Benefits

Sea pandanus, also known as pandanus mat (Pandanus tectorius Park), is native to islands in the Pacific, Northern Australia, Southeast Asia, and South Asia (Heyne, 1987; Thomson et al., 2006; Adkar & Bhaskar, 2014). It grows near the coast to the mainland with a height of up to 600 m above sea level, even more (Thomson et al., 2006). Sea pandanus grows near beaches, rivers, ponds, channels or other bodies of water (Figure 1).

***Figure 1.*** *Sea pandanus tree (Pandanus tectorius Park.)*

Sea pandanus that grows near the coast is also known as a follow-up plant in mangroves. The hallmark of the sea pandan is the tunjang root that grows from the stem with a length of up to 1 m. The existence of these support roots provides the benefit of strengthening the erection of the plant stems and a fortress against big waves in protecting the plants behind the sea pandanus plantation. The spread of this plant is thought to be throughout the coast of Indonesia (Hani and Dendang, 2008).

Sea pandanus habitat in the form of large shrubs or trees with a height of up to 14 m. This plant's crown (canopy) has dichotomous branches at the height of approximately 4m. Stems are sometimes spiny with a size of 4mm and have lenticels, gray, internodes 1-1.5cm diameter 9.1-14cm. The taproot that grows from the stem is more than 1 m long, with a 1.5-5.1 cm (Thomson et al., 2006; Rahayu & Handayani, 2008).

The sea pandan leaf is a single leaf in the form of a ribbon, 1-3 m long and 8-12 cm wide, with a pointed tip, the leaf margin (margo folii), and the leaf bone's underside (costa) have spines. The upper surface of the leaf is green. The lower surface is yellowish-green. The spiral leaves are arranged in three positions (Thomson et al., 2006; Rahayu & Handayani, 2008).

Sea pandanus plants are dioecious. Male and female flowers are found in different individuals. The male sea pandanus flower is in the form of a cob measuring 25-60 cm, hanging covered in a yellow, white sheath and has a distinctive aroma. Located at the end of the stem, many stamens are prominent. The female flowers are like pineapple flowers, located terminal or lateral, solitary, in the form of spikes or large panicles (Figure 2) (Backer & Brink, 1966).

***Figure 2.*** *Male and Female P tectorius flowers (Photo C. Elevitech)*

Sea pandanus fruit, such as pineapple fruit called cephalium, is a compound fruit composed of phalanges or drupes or keys when ripe yellowish red. The number of phalanges ranges from 38 to 200. The fruit is oval with a diameter of 12.7-20.3cm, a length of 15.2-25.4cm and a weight of 1-1.5kg. At the top of the phalanges is a visible stigma. The number of stigmas indicates the number of seeds contained in the fruit. Seeds are obovoid, ellipsoid or oblong, 6-22mm long, reddish-brown on the outside and whitish on the inside (Rahayu & Handayani, 2008; Rahayu et al., 2008; Adkar & Bhaskar, 2014; Gurmeet & Amrita, 2015).

Sea pandan has many functions and benefits. Ecological functions to withstand coastal abrasion, resist wind, reduce the impact of tides on terrestrial ecosystems, mitigate tsunamis and have an impact on minimizing damage to the area behind the pandanus vegetation. Post-tsunami observations on the coast of Pangandaran, Ciamis Regency, which are densely overgrown with pandanus, can withstand the brunt of the tsunami. The plants behind the belt formation are safe from the brunt of the tsunami (Hani and Dendang, 2008). Sea pandanus is resistant to drought, strong winds and salt spray (Thomson et al., 2006).

In general, all parts of this plant can be used for human purposes. The people of Micronesia make the fruit a staple food (Thomson et al., 2006). The content of -carotene, carbohydrates, protein, fat and fibre in fruit makes it possible to be used as processed food ingredients (Sarunggallo et al., 2018). The root is used for house walls, basket handles, brush handles and ropes—the central rod for house construction materials, the manufacture of stairs. Leaves are used as roofs, making mats, hats, sails and baskets (Thomson et al., 2006; Gurmeet and Amrita, 2015). The people of Ujung Kulon utilize leaf fibre for making mats as their daily livelihood (Rahayu et al., 2008) and are used as raw materials in the weaving industry (Ashish et al., 2015). Sea pandanus is used for traditional ceremonies in Micronesia and Hawaii, while the male flower is used (Thomson et al., 2006).

The leaves and roots can be used for traditional medicine. The stem bark contains cytotoxic steroids for human epidermal carcinoma (Hoa et al., 2014). The Kiribati people use pandan leaves to treat colds, hepatitis, difficulty urinating (dysuria), asthma, ulcers and cancer. A decoction of the roots of this plant is used to treat haemorrhoids. Hawaiians use the fruit, male flowers and tunjang roots for traditional medicinal ingredients. Its use can be singly or combined to treat digestive and respiratory disorders (Thomson et al., 2006).

Sea pandanus contains phytochemical compounds including steroids, phenols, isoflavones, alkaloids, lignans, coumestrol, glycosides (Thomson et al., 2006; Gurmeet and Amrita, 2015), benzofuran derivatives, -terpineol, -carotene, -sitosterol, vitamin C, tangerine, germacrene-B and vanidine (Adkar and Bhaskar, 2014). The presence of phytochemical content in this plant correlates with its ability as an antimicrobial, antidiabetic, antiviral, antineoplastic, antioxidant, antidiuretic, analgesic and neuroprotective (Gurmeet and Amrita, 2015). Flavonoids (from leaves and fruit) and alkaloids in the leaves of this plant have cytotoxic abilities against T47D cells (Holle et al., 2013). The fruit of this plant contains phenolics, flavonoids, terpenoids, steroids, saponins and glycosides that can be used as antioxidants and antibacterials (Andriani, Ramli, et al., 2015).

The content of caffeoylquinic acid compounds found in fruit is used as an antihyperlipidemic (Liu et al. 2013). The isolation of secondary metabolites of sea pandan

fruit obtained 15 compounds (10 phenolic compounds and five flavonoid compounds), including vanillin, trans-ethyl caffeate, tangeretin, chrysin and naringenin (Xiaopo et al., 2012). Vanillin can inhibit the action of tyrosinase (Gong et al., 2006) and as an antioxidant (Burri et al., 1989); trans-ethyl caffeate and tangeretin have potential for anti-atherosclerosis and are cytotoxic against the HepG2 cell line (Andriani, Pangestika, et al., 2019); Chrysin can be utilized as an apoptotic effect (Khoo et al., 2010); Naringenin is antiviral (Nahmias et al., 2008) and lowers cholesterol levels (Lee et al., 1999).

### 2.2 Propagation of Sea Pandanus Plants

Sea pandanus naturally reproduces by seeds. Seed production through seeds takes a long time. The seeding process begins with soaking in water for five days, and on average, it will germinate after two months of seeding. To get seeds ready to be grown in the field, the total seed production time can reach six months (Hani & Dendang, 2008). Although it is easy to do, inexpensive can produce seeds in mass quantities and does not require advanced technology, seed production through seeds will produce plants that are not identical to the parent, and the sex of the plant is also unknown (Thomson et al., 2006).

Another way to produce sea pandan seeds suitable for their parents is by using stem cuttings. Stem cuttings can produce seeds of the same sex as the parent (Thomson et al., 2006; Gallaher, 2014). The length of the cuttings used as propagation material is 30-40cm by cutting the leaves up to 70%. Planting stem cuttings can be done immediately or after all the cuttings collection has been collected (Thomson et al., 2006; Gurmeet & Amrita, 2015). After two months of planting in polybags, the growth of stem cuttings showed that more than 70% succeeded in growing. Seed growth produced from stem cuttings also has typical morphological characteristics (Rahayu et al., 2015).

The way to produce sea pandan seeds without damaging the parent tree is to separate the tillers or side shoots, otherwise known as “sengke” or “sengket” (Rahayu et al., 2008; Susiarti & Rahayu, 2010; Gurmeet & Amrita, 2015). Side shoots with long roots are separated from their parents and then planted in a small wetland with a spacing of 1x2m and a depth of 20-30cm. There is no information about the number of tillers from the mother tree, but from experience growing sea pandan seeds, it can be seen that the number of tillers can reach 3 in one growing period, and not all plants produce tillers.

## III. Research Methods

The research was carried out in Depok from January to July 2020. The time prepared was following the assumption of research needs. The time specified in the implementation of this research has gone through a calculation process following research needs based on the principles of effectiveness and efficiency.

The tools and materials needed in this research are sea pandanus fruit/seeds, polybags, growing media, stationery and a sprayer. The tools used in this study have gone through a selection process under research needs based on the principles of effectiveness and efficiency.

The way these research works is as described in the following explanation. Before soaking, some of the mesocarp at the base of the fruit is removed and then soaked for five days, four days, three days, two days and one day. For soaking for more than one day, the water is changed every day. After soaking for one day, the fruits/seeds are planted in 23.5x25cm polybags. Each polybag contains two pieces/seeds. Likewise, the fruits/seeds that are soaked for 2, 3, 4 and 5 days are planted in polybags containing two pieces/seeds. The number of fruits/seeds used is 100 pieces. Seeds planted in polybags are maintained and watered every day. Parameters were recorded. Starting the seeds to germinate was indicated by the presence of growing shoots. Furthermore, after the seeds were two months old since the shoots appeared, the seeds' height and root length parameters were measured.

The design model in the data analysis was Completely Randomized Design (CRD), five treatments of soaking fruit/seeds (1 day, two days, three days, four days and five days), and ten replicates. Analysis of variance was carried out using the F test. If Fcount>Ftable, the test results were significantly different at the 95% confidence level. The test results that were significantly different (significantly) were further tested for the Least Significant Difference (BNT). Data processing was carried out using the SPSS 20.0 for Windows program.

## IV. Discussion

Sea pandanus (Pandanus tectorius Park.) is a living plant whose humans use all parts. This plant has bright prospects to be developed in the future. Ecological benefits as abrasion resistance, wind resistance and tsunami mitigation. Household craft materials such as mats, baskets and so on. Sea pandanus can also be planted in the office yard for aesthetics. The presence of secondary metabolites in pandan fruit and leaves can be used as an ingredient for treatment, even the leaves can be used in the fiber industry. Propagation of this plant can be done through seeds and cuttings. Cultivation techniques for sea pandanus have been carried out to determine the effect of polybag size and growth media on germination. The success of germination is one of the determinants of plant cultivation success. Sea pandan seeds are recalcitrant seeds, seeds that are difficult to germinate. For this reason, it is necessary to conduct research related to the acceleration of germination.

Soaking fruit/seeds that have partially removed the mesocarp for 1 to 5 days grow shoots from day 37 to day 41. Fruits/seeds soaked for five days, four days, three days, two days, and one day grew to form shoots in a row starting on the 37th, 38th, 39th, 40th and 41st days. The emergence of shoots from fruits/seeds soaked for 1-5 days did not show a significant difference. In other words, one day of immersion was not different from 2,3,4 and 5 days of immersion in growing shoots (seeds).

The immersion time gave the same response pattern on the 39th and 177th days of observation. The 177th day gave more growth than the 39th day (Figure 3). Overall, there was no difference between the immersion time treatments.

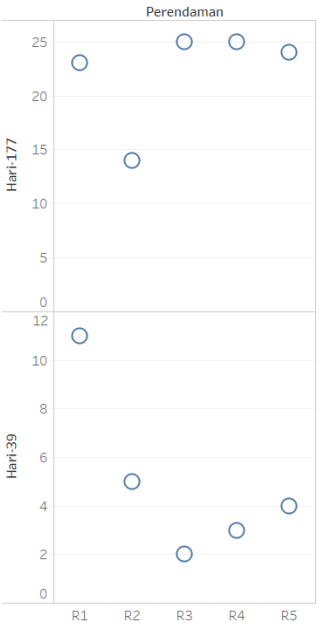


***Figure 3.*** *Total Number of Seeds Growing Based on Soaking Time and Days*

Based on Figure 3 above, it can be seen that the number of seeds in the 1-day soaking treatment on the 39th day was 11, which was the highest number, while the least amounted to

2 in the 3-day soaking treatment. The highest number of seeds on the 177th day, as many as 25, was found in the three and 4-day immersion treatments. The least number of seeds on the 177th day was 14 seeds in the 2-day soaking treatment.

The proportion of seed growth on the 39th day based on the treatment duration of soaking sea pandan fruit/seeds can be seen in Figure 4, and the proportion of seed growth on the 177th day can be seen in Figure 5.

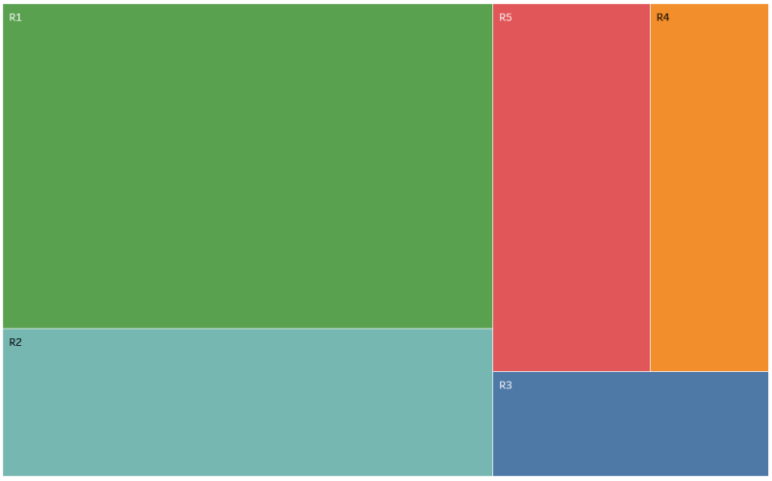


***Figure 4.*** *Proportion of Number of Seeds Growing Day 39*

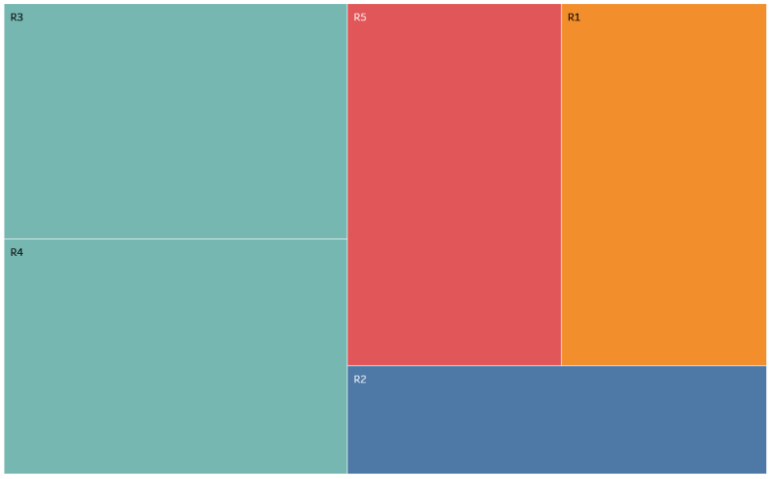


***Figure 5.*** *Proportion of Number of Seeds Growing Day 177*

The height and length of the 2-month-old seed roots obtained in this study are shown in the following table. Seed height ranged from 30.0-42.3cm, and root length ranged from 35.6-46.3cm. The shoot and root ratio of this study ranged from 0.7 to 1.05.

**Table 1.** Root Length and Seed Height of Sea Pandan Age 2 Months

| | Root Length (cm) | | Seed Height (cm) | |
|---|---|---|---|---|
| Treatment | Average | sd | Average | sd |
| R1 | 41.7 | 10.1 | 38.8 | 6.3 |
| R2 | 46.3 | 12.8 | 42.3 | 6.6 |
| R3 | 40.1 | 8.8 | 30.0 | 4.1 |
| R4 | 35.6 | 12.8 | 37.6 | 6.4 |
| R5 | 44.2 | 11.3 | 42.6 | 3.8 |
| Total | 41.5 | 11.4 | 38.0 | 7.1 |

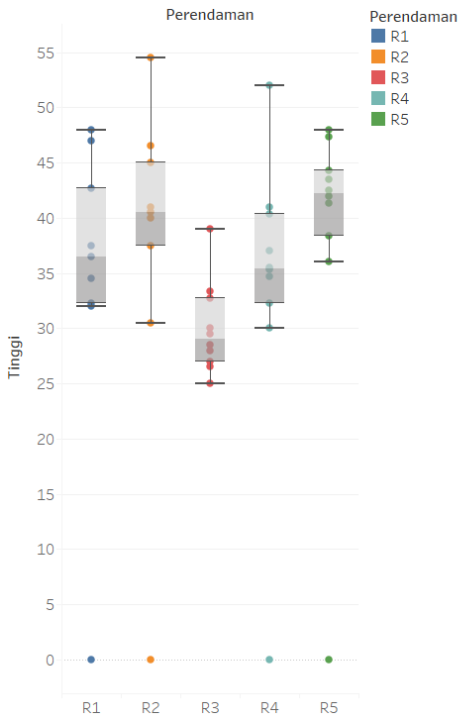


***Figure 6.*** *Boxplot of Sea Pandan Seed Height*

The analysis results showed no difference in root length between soaking days, but there was a difference in plant height. The results of the analysis of mean differences after ANOVA with Tukey's test showed that the level of immersion treatment for three days gave shorter plants than all other treatment levels. In Figure 7 below, it can be seen that the variable length of the root shows a considerable variation in the data.

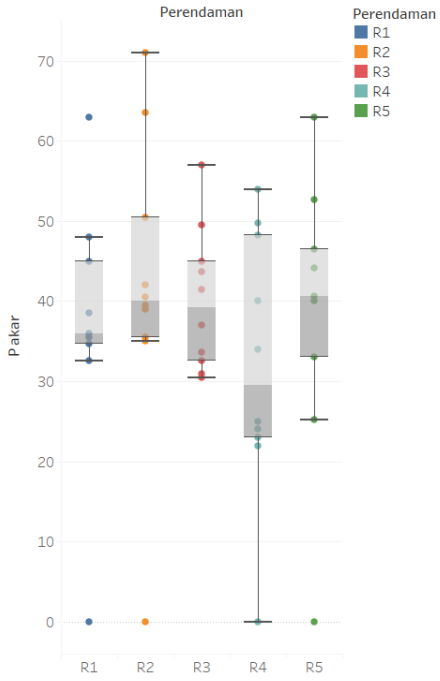


***Figure 7.*** *Boxplot of Sea Pandan Seed Root Length*

The treatment of removing some of the fruit mesocarps can accelerate the occurrence of imbibition so that the embryos contained in the seeds grow faster. Naturally, the seeds will start to germinate after two months of planting (Thomson et al., 2006), but in this study, shoot

growth appeared on the 37th day for five days of immersion, 38th day of 4 days of immersion and 41st-day one-day immersion. The research results by Rahayu et al., 2015 sprouted on the 44th day. This research is even faster, 3-7 days. Treatment of 5 days, 4, 3, 2 and 1 day immersion did not differ on the emergence of shoots for the first time. The Mesocarp removal technique can speed up germination time even though soaking time does not have to be five days, just one day.

In this study, the root length and height of the two-month-old seeds were higher than those obtained by Hani and Dendang, 2008. Seed quality and growth medium could affect the fertility of sprouts. In Hani and With's 2008 study, the growth medium was a mixture of sand and soil, while this study used plant media obtained from compost.

The difference in the immersion treatment did not show a difference with the length of the root of the seed, while for the height of the seed, the three-day immersion treatment had the smallest value. Thus, one day of immersion can replace 2, 3, 4 and 5 days of immersion. Soaking for one day by removing a small portion of the fruit mesocarp can be done to obtain seeds ready to be planted in the field.

## V. Conclusion

After undergoing this research, conclusions can be drawn that are relevant to the results and analysis in the previous chapters. The conclusions are as follows:

1. Removing some of the fruit mesocarps accelerates the growth of sprouts. The treatment of removing some of the fruit mesocarps can accelerate the occurrence of imbibition so that the embryos contained in the seeds grow faster.
2. The immersion time does not affect the early growth of sprouts. Treatment of 5 days, 4, 3, 2 and 1 day immersion did not differ on the emergence of shoots for the first time. This condition means the Mesocarp removal technique can speed up germination time; even soaking time does not have to be five days, just one day.
3. Soaking time did not affect the value of root length and height of two-month-old seeds. The difference in the immersion treatment did not show a difference with the length of the root of the seed, while for the height of the seed, the three-day immersion treatment had the smallest value. Thus, one day of immersion can replace 2, 3, 4 and 5 days of immersion. Soaking for one day by removing a small portion of the fruit mesocarp can be done to obtain seeds ready to be planted in the field.

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