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Growth performance of lapnisan (*Aquilaria malaccensis* Roxb) seedlings in varying sand concentrations

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Abstract

The International Union for Conservation of Nature (IUCN) Red List has categorized the Southeast Asian native species *Aquilaria malaccensis* as severely endangered due to the great demand for its agarwood. The purpose of the study was to assess the growth performance of Lapnisan (*Aquilaria malaccensis*) seedlings in varying sand concentrations. The study employed a Complete Randomized Design (CRD) method with four treatments, this include Treatment 1 (T1)-pure top soil, Treatment 2 (T2)- topsoil and sand soil (1:1 ratio), Treatment 3 (T3)- topsoil and sand soil (3:1 ratio), and Treatment 4 (T4)- topsoil and sand soil (1:3 ratio) with three replications per treatment. The effects of these treatments were evaluated based on percent survival, number of leaves, branches and stem diameter. Based on the study, there were significant differences among the treatments. Lapnisan seedlings in T2 produced more branches (3.78) and a greater number of leaves (39.56) compared to the other treatments. In contrast, Lapnisan in T3 developed a thicker stem diameter (6.89). Notably, Lapnisan seedlings in Treatment 4 achieved a 100% survival rate out of the four treatments. These results suggested that a high sand concentration is the most suitable for cultivating Lapnisan seedlings, as it significantly increased their chance of survival.

Keywords: *Aquilaria malaccensis*, Sand, Topsoil, Percent survival

Introduction

Deforestation and the use of trees for commercial purposes are one of the problems in the world. Destruction of forest ecosystems in the Philippines are mainly due to extreme timber harvesting, rapid deforestation, and expansion of agricultural and human settlement (Bensel as cited by Coracero et al., 2022). It is native to Southeast Asia, such as Indonesia, Malaysia, Philippines, Thailand, Singapore and Bhutan (Thompson et al., 2022). The genus *Aquilaria* belongs to the family Thymelaeaceae, which includes massive evergreen trees that are sporadically found in tropical rainforests (Nahar et al., 2023). Agarwood is a rare by product of a few genera of Aquilaria and Gyrinops, according to Akter, who was quoted by Chen, 2025). According to Lee and Mohamed (2016), *Aquilaria malaccensis* Roxb., also called Lapnisan or Agarwood, is a highly prized tree species that produces agarwood, a fragrant resin used in traditional medicine and perfumery. According to criterion A2cd, *Aquilaria malaccensis* is classified as Critically Endangered under IUCN Red List of Threatened Species (Harvey-Brown, 2018). Since agarwood is only found in a small portion of *Aquilaria* trees belonging to the species that are known to produce it, the supply is restricted by nature. The availability of agarwood is unfortunately greatly outstripped by the demand for it nowadays (Barden et al., 2000).

The most popular addition to growth media is sand. Sand composition varies greatly. If the sand is used sparingly, some plants growing in the greenhouse

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might be acclimated to the calcareous soil conditions in the area and might not be negatively impacted by the elevated pH (APEX, 2025). Topsoil by itself, however, isn't always the best growing medium because it might occasionally be too dense for roots and air to pass through. Topsoil, or soil extracted from the earth's outermost layer, is the most often used growing medium for plants, according to Tababa (2023). Sand is great for growing plant cuttings because it provides stability and plenty of drainage, which lowers the chance of root rot. Thus, this study wants to assess the growth performance of Lapnisan seedlings in varying sand concentration. Specifically, it aims to determine the growth performance of Lapnisan (*Aquilaria malaccensis* Roxb.) and the significant differences in the rate of survival of Lapnisan using topsoil and sand soil.

Methodology

Study site

The study was conducted at the Nueva Vizcaya State University - Bayombong Campus, College of Forestry, Environment and Resource Management (CFERM). The experiment was conducted within three months.

Experimental design

The study was laid out in a Completely Randomized Design (CRD). There were four (4) treatments, each of which was replicated three times, for a total of 36 seedlings. The study comprised four (4) treatments, including the control (Table 1).

Table 1. Treatments and description

Treatments	Descriptions
Treatment 1	Pure top soil
Treatment 2	Combination of Topsoil (1kl) and sand soil (1kl)
Treatment 3	Combination of Topsoil (3kl) and sand soil (1kl)
Treatment 4	Combination of Topsoil (1kl) and sand soil (3kl)

Materials

The following materials were used; Bolo was used to cut the bamboo culm. Nets, bamboo culms and rope were used to establish the nursery. 6x10 polyethylene bags were used to re-bag the seedlings. A sieve was used to separate smaller particles from larger ones. Topsoil and sand soil were used as the substrate in this study. Containers were used to mix the substrate. While, the garden shovel was used to transplant the soil. Ruler, Digital caliper, and notebook were used for data collection.

Preparation of the Lapnisan seedlings

The Lapnisan seedlings used in this study were obtained from the College of Forestry, Environment and Resources Management (CFERM), Nueva Vizcaya State University Bayombong, Nueva Vizcaya, Philippines.

Preparation and procedure

This study was conducted at CFERM, Nueva Vizcaya State University, Bayombong, Nueva Vizcaya (NVSU), where a nursery was established at the university. In this research, 36 Lapnisan seedlings were used. On the other hand, the topsoil and sand soil used as substrates were collected outside the NVSU campus. Lapnisan seedlings were then re-potted in 6x10 polyethylene bags with varying ratios of sand soil and topsoil. The initial number of leaves, number of branches, and stem diameter of Lapnisan were measured after repotting, accompanied by regular visitation and watering throughout the study. Consequently, monthly measurements of Lapnisan seedlings were performed for three months of observation.

Data collection

The following growth parameters were assessed:

1. Percent survival

Percent survival was determined using the following formula:

$$\text{Percent survival} = \frac{\text{Number of alive Lapnisan seedlings}}{\text{Total number of Lapnisan sseedlings}} \text{ X } 100$$

2. Number of leaves

The number of leaves of the seedlings were manually counted.

3. Number of branches

This number of branches were measured by manually counting the branches.

4. Stem diameter

Using a calibrated caliper, the diameter of the seedling were measured in millimeter.

Data Analysis

The data collected were analyzed using Analysis of Variance (ANOVA), and Statistical Tool for Agricultural Research (STAR) application of International Rice Research Institute (IRRI) to determine the differences among treatments and the significance between the treatments with $p<0.05$ level of significance.

Result and discussion

Number of branches

Based on the results, Lapnisan seedlings treated with 1:1 ratio of topsoil and sand soil (Treatment 2) have the highest number of branches produced with a mean of 3.78 (Figure 1). This indicated that equal concentration of topsoil and sand soil has good effect on branch production. These results suggested the potential for using a 1:1 ratio of topsoil and sand soil to improve the number of branches in Lapnisan. In addition, this aligned with the findings by Talucder et al. (2016), who reported that *Aquilaria malaccensis* can be supported by calcareous, sandy, and rocky slopes and ridges with good drainage can support *Aquilaria malaccensis*. On the other hand, seedlings treated with 3:1 ratio of topsoil and sand soil (treatment 3) demonstrated a high number of branches with a mean of 3.1. However, this contradicted the study of Bhardwaj (2014), its results found out that a medium compost of vermicompost, pond soil, and sand soil in a 1:1:1 ratio was the most suitable for papaya seedlings growth and development, leading to increase in stem girth and leaf number. Moreover, Lapnisan seedlings treated with pure topsoil (Treatment 1, the control) yielded the lowest number of branches with a mean of 2.33. Statistical analysis, however, showed no significant differences between the treatments.

Number of leaves

Lapnisan seedlings treated with 1:1 ratio of topsoil and sand soil (treatment 2) had the highest mean number of leaves with a mean of 39.56. This indicated that an equal concentration of topsoil and sand soil also has a positive effect on the leaf production of Lapnisan (Figure 2). Meanwhile, Lapnisan seedlings treated with 3:1 ratio of topsoil and sand soil (treatment 3) also produced a high number of leaves, with a mean of 25.78. According to Waziri et al. (2015), which Ambebe et al. (2018) cited, the sand-based media's beneficial effects on sprouting, leaf count, plant height, diameter, and leaf size were probably caused by the water and nutrients' easy translocation to the aboveground portions, which was made possible by the increased potential for root growth and function. Additionally, plant roots can benefit from the warmth that sand provides during cooler growing seasons, as it heats up quickly and retain heat efficiently (ICL, 2025). Moreover, it was observed that Lapnisan seedlings treated with 1:3 ratio of topsoil and sand (Treatment 4) had the weakest potential for producing new leaves, with the mean of 10.74. These results contradicted the study by Shwerif et al. (2020), who assessed the growth and productivity of Solanum lycopersicum in different soil types and found that sandy soil produced better height and number of leaves compared to clay soil. Therefore, different concentrations of topsoil and sand soil have significant effects on the number of leaves of Lapnisan.

Stem diameter

Figure 3 indicated that Treatment 3 (3:1 ratio of topsoil and sand soil) has the highest diameter increment with mean of 6.89 for Lapnisan during the three month observation period. It only showed that within 3 months of observation, the ratio in T-3 signifies advances in the growth of Lapnisan in-terms of diameter increment. This is followed by Treatment 2 (1:1 ratio of topsoil and sand soil) with a mean of 6.56. Based on the study of Saikia and Shrivastava (2012), the agar tree produced somewhat straight stems and thrives in sandy-to-sandy clay soil. Additionally, the ability of the soil to retain

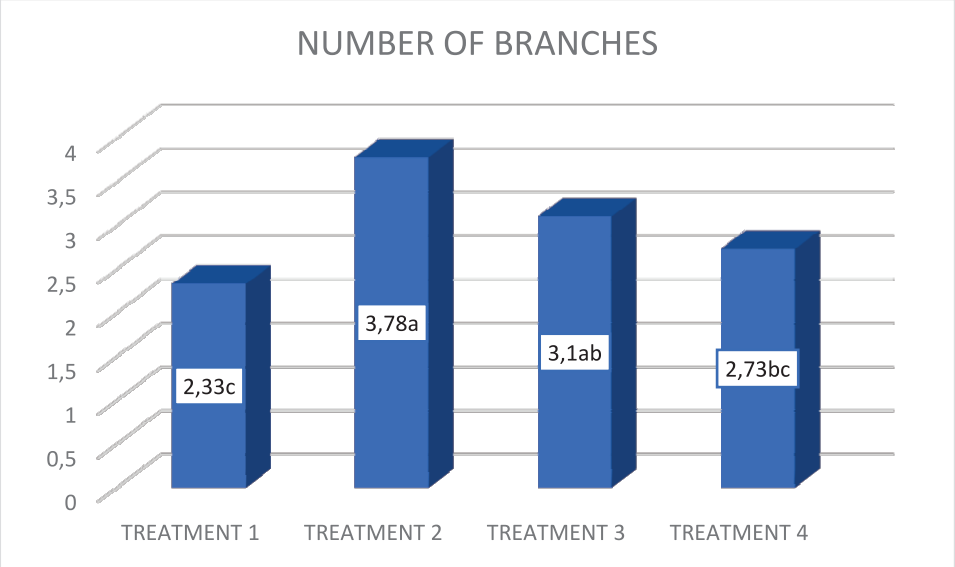

Figure 1. Number of branches of Lapnisan seedlings

water is found to be the most crucial factor in Lapnisan growth and survival; thicker stem can store more water and nutrients, acting as a reservoir during dry spells (BW Fusion, 2024). Due to its capacity to retain water, infiltration, and fertility in supporting living things, soil has a major impact on plant growth (Shwerif et al., 2020). These results suggested that different treatments have significant effect on the stem diameter of Lapnisan seedlings. The study's findings are further supported by the fact that Treatment 2 has more branches and leaves, because a stronger stem with a well-developed vascular system effectively transfers water and other essential nutrients from the roots to the leaves, maximizing photosynthesis and overall growth.

Percent survival of lapnisan seedlings

The results showed that treatment 4 (1 topsoil: 3 sand) had a higher survival rate (100%) than the other treatments (Figure 4). This has indicated that pure sand is ideal to use to enhance the survival percentage of Lapnisan. This is supported by ICL (2025), which noted that sand is a flexible and useful ingredient in growing media that can enhance plant root development, aeration, and drainage. Additionally, using a soil-based growth medium can lead to reduced crop productivity because natural soils contain microorganisms, water, air, variable nutrition, and weeds that can cause stress to seedlings (Ephrem et al., 2022, citing research by Baiyeri and Mbah, 2006; Landis et al., 1990). However, the findings contradicted the study of Garg and Kumar

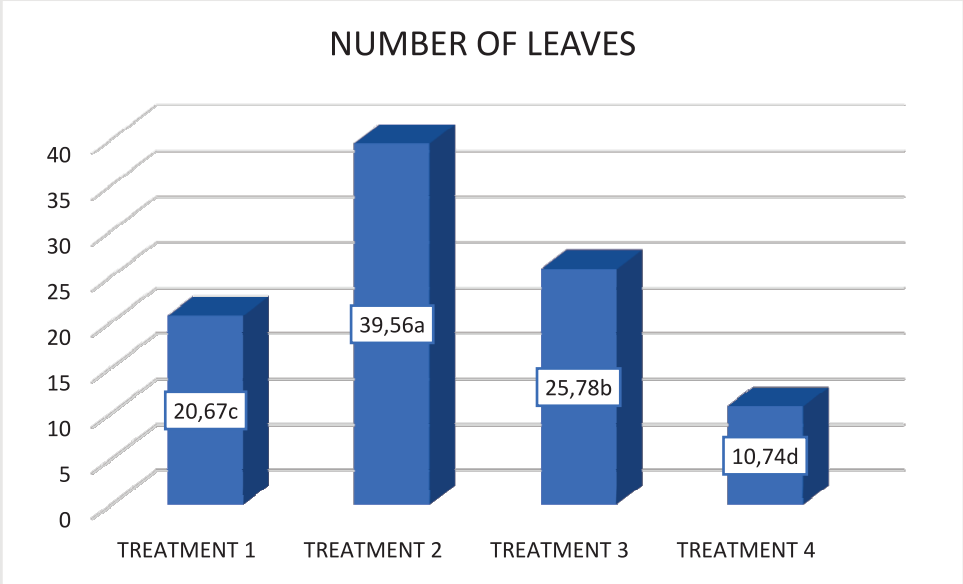

Figure 2. Number of leaves of Lapnisan seedlings

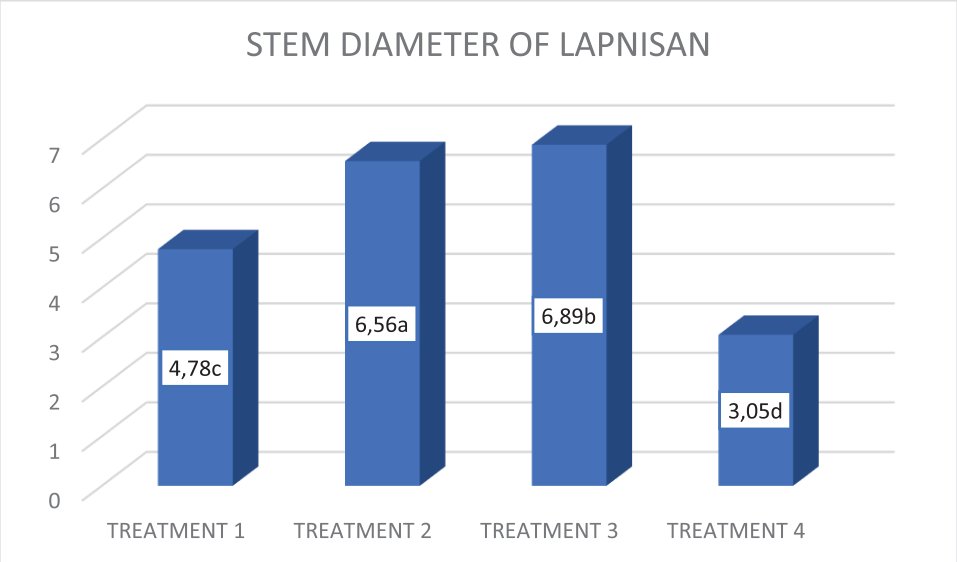

Figure 3. Stem diameter of Lapnisan seedlings

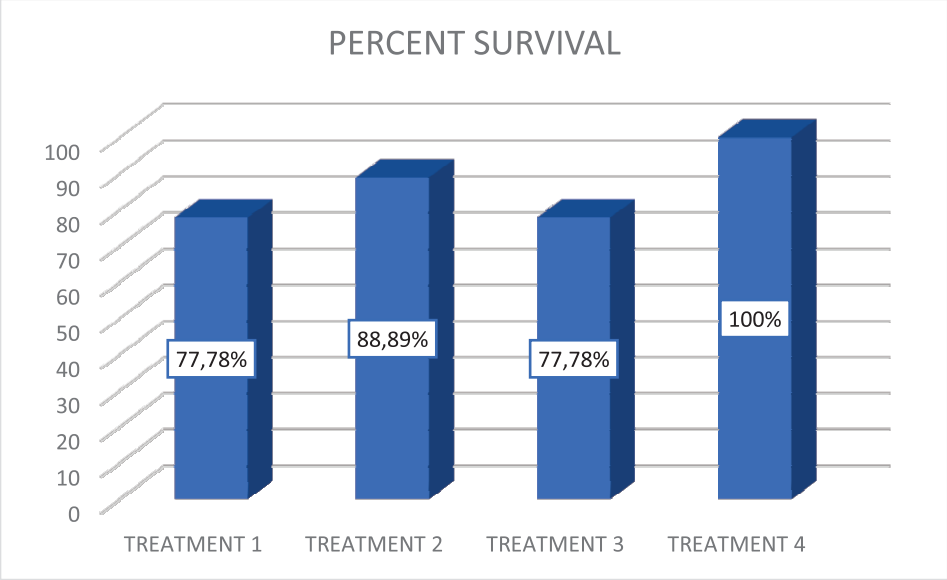

Figure 4. Percent survival of Lapnisan seedlings

(2012), when they evaluated the effects of various soil types on *Euphorbia lathyrism* and found that plants raised in sandy soil showed comparatively poor growth, chlorophyll development, and hexane extractables.

Conclusions

In this study, four different concentrations of sand were used. Among the different variations of sand and top soil, Treatment 2 (1 sand: 1 topsoil) resulted in a higher number of branches and leaves, while Treatment 3 (3 top soil: 1 sand) led to an increase in stem diameter. Among the four treatments, Treatment 4 (1 top soil: 3 sand) has a 100% survival rate of Lapnisan seedlings. The results indicated a significant difference between the four treatments. Based on the findings it is suggested that sand is ideal to be used in growing Lapnisan seedlings since it provided a higher survival rate. Further exploration and studies on the varying concentrations of sand is needed to determine its applicability for other plant species.

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