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Full Length Research Article

Evaluation of an Agroforestry System: The Growth of 14-Month-Old Solomon Sengon (*Falcataria moluccana*) and Rice (*Oryza sativa*)

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ABSTRACT

Solomon sengon is a provenance of sengon that grows faster than other local sengon species. The species is often cultivated in an agroforestry system, which can be combined with rice as the staple food in Indonesia. Competition between those two components to obtain the sunlight and nutrients is getting higher as sengon grows. LIPI and IPB have discovered several rice varieties. However, there has not been much research done on agroforestry between Solomon sengon (*Falcataria moluccana*) and rice (*Oryza sativa*) varieties. This study aimed to analyze the growth of Solomon sengon at 14 months old and the productivity of several rice varieties. This study used a completely randomized factorial design with two factors, namely the tree spacing factor of Solomon sengon type F2 (1.5 m × 3 m and 1.5 m × 1.5 m) and the factor of upland rice varieties (LIPI Go 1, LIPI Go 2, and IPB 9G) also lowland rice (IPB 3S). Parameters observed were sengon growth and rice productivity. Data were analyzed statistically using the analysis of variance (ANOVA) test and the Duncan test with a confidence interval of 95%. The results showed that the 14-month-old Solomon sengon with a tree spacing of 1.5 m × 3 m has a higher diameter, height, and canopy area than a tree spacing of 1.5 m × 1.5 m. The rice varieties of LIPI Go 1, LIPI Go 2, IPB 9G, and IPB 3S planted under 14-month-old sengon with a tree spacing of 1.5 m × 3 m have higher productivity than rice planted under sengon with a tree spacing of 1.5 m × 1.5 m. Rice varieties significantly affected several rice growth parameters. IPB 3S has the optimum growth and production in this study. IPB 3S is the variety with the highest number of tillers per clump and the highest number of productive tillers per clump. IPB 3S is the variety with the highest number of tillers per clump and the highest number of productive tillers per clump.

1. Introduction

The increasing need for food in Indonesia can be overcome by planting rice to meet the community's needs. However, agroforestry can be used as an alternative to increasing the production of food sources, considering the area of agricultural land is decreasing. The agroforestry system is a land-use management system that combines agriculture and forest practices by planting agricultural crops and forestry trees to be managed as a sustainable system (Agu and Nonbenni 2019; Sarminah et al. 2018).

From an agroecological perspective, agroforestry forms multi strata canopy layers which are beneficial for soil conservation since they can reduce the speed of rainwater and minimize the potential risk of erosion caused by run-off water. Furthermore, with the soil structure maintained from run-off water, agroforestry can increase the soil nutrient availability due to the litterfall from the trees (Dollinger and Jose 2018). In addition, the soil in the agroforestry system has more advantages than that in monoculture crops since it has more microbial diversity (Udawatta 2019), which can improve soil fertility (Iskandar et al. 2017).

Sengon is one of the most widely cultivated trees in agroforestry systems and one of the tree species that is gaining popularity to be cultivated in agroforestry. Sengon is very developed because it is a fast-growing species with a relatively high economic value. Solomon sengon is a provenance that grows faster than local sengon. Sengon is fast-growing tree species and very easy to adapt to various soil conditions (Krisnawati et al. 2011; Wasis and Saidah 2019).

The light and open canopy of sengon is the reason that the land under sengon stands can be used to grow agricultural crops such as upland rice (Senjaya et al. 2018). In the agroforestry system, sengon is an ideal tree species because it has an open crown, making the light go through the ground. The lower canopy space can be cultivated with agricultural crops (Wijayanto and Pratiwi 2011). The commonly used undergrowth crops in the agroforestry system are food-producing plants, for example, rice. Rice has a high economic value for the community, either self-consumed or as cash income (Nurliza et al. 2017; Kadigi et al. 2020). Therefore, Sengon (*Paraserianthes falcataria (L.)* Nielsen) is a plant many people choose to plant on community forest land in an agroforestry system. In addition, to its short lifespan, the advantage of sengon as the main plant in agroforestry systems is that it has a light and open canopy so that sunlight can enter the forest floor. Furthermore, sengon comes from the legume family, which is known to have roots with the ability to bind nitrogen (Nugroho et al. 2018; Senjaya et al. 2018).

The planting pattern of sengon in an agroforestry system can affect the growth of sengon and the undergrowth crops, especially as the age of sengon increases (Azizah 2019). Tree spacing can also affect canopy characteristics and wood quality (Tun et al. 2018). Therefore, spacing needs to be adjusted to grow undergrowth seasonal crops or agricultural crops optimally (Wijayanto and Nurunnajah 2012). For example, Senjaya et al. (2018) found that upland rice planted under a 3-month-old sengon in agroforestry land with a tree spacing of 1.5 m × 1.5 m did not affect upland rice production or growth of sengon. In contrast, upland rice planted under a 2-year-old sengon with a tree spacing of 2.5 m × 2.5 m reduced upland rice production due to the lack of received sunlight (Senjaya et al. 2018). In another study, a three-year-old sengon stand at 3 m × 3 m spacing can increase the growth of height, stem diameter, and root length of sengon compared to a monoculture system (Ningrum et al. 2019). Upland rice is a type of rice that can adapt well to dry land so that this rice can be developed in an agroforestry system. However, the growth of sengon and upland rice in agroforestry systems is influenced by crop competition. Therefore, it is necessary to know the treatment that supports the growth of Solomon sengon and rice varieties that can grow well in agroforestry systems.

Upland rice, cultivated on dry land (fields), is a common food crop grown in agroforestry systems. According to Tarigan et al. (2019), upland rice is one of the essential crops in the agricultural system in Indonesia as a source of staple food. Research on the agroforestry system of sengon and upland rice when sengon is still young and the crown is not yet dense has been carried out (Azizah 2019; Ningrum et al. 2019; Senjaya et al.2018). This study aimed to analyze the effect of tree spacing of 14-month-old Solomon sengon on its growth and the growth of several upland rice varieties in agroforestry systems.

2. Materials and Methods

2.1. Research Time and Location

This research was conducted from October 2019 to February 2020. The research is located in the Cikabayan Forest, Bogor Agricultural University Campus, Darmaga, Bogor (**Fig. 1**). The location has a slope of 0% and is located at an altitude of 162 masl.

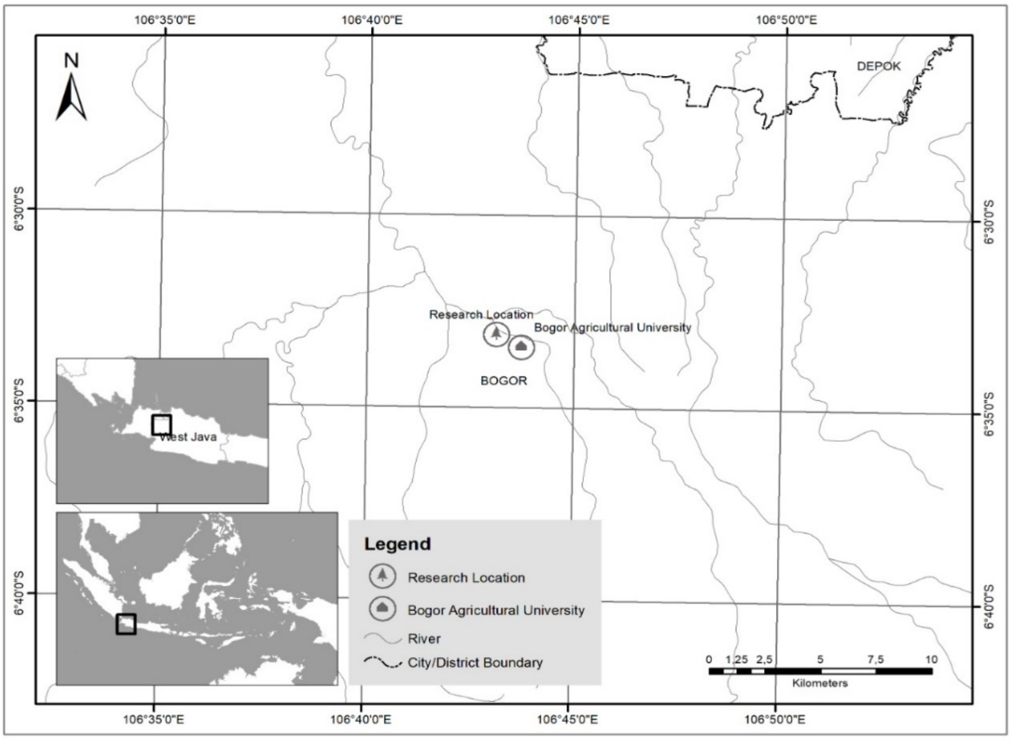

Fig. 1. Map of the experimental site in Cikabayan Forest, IPB University, Bogor, West Java, Indonesia.

2.2. Materials

The tools used in this research were planting plot marker labels, stakes, meter tape, soil drill, analytical balance, ruler, lux meter, thermohygrometer, oven dryer, stationery, camera, and SPSS software. The materials used in the study were the stands of Solomon sengon type F2 aged 14 months old, rice seeds of LIPI Go 1, LIPI Go 2, IPB 3S, IPB 9G, compost, manure, biological organic fertilizer (POH) from LIPI, urea fertilizer, SP36 fertilizer, fertilizer KCl, furadan, and insecticide with the active ingredient fipronil.

The materials used in this research were seeds Solomon sengon type F2 Solomon sengon type F2 seeds were obtained from community forests in Kendal Regency, Central Java. Upland rice seeds were obtained from previous research conducted in the Cikabayan Forest, Darmaga Campus of IPB, Bogor Regency (Azizah 2019). The four varieties are classified as New Superior Varieties (VUB). Before planting, rice seeds were soaked in a water mixture and POH for 24 h to break seed dormancy. Tree spacing and sengon variety did not significantly affect all rice growth variables. The agroforestry condition that was able to produce the highest potential yield of 3.13

tons/ha was the LIPI Go 1 variety planted under local Kendal sengon stands at a spacing of 3.0 m x 1.5 m (Azizah 2019).

The main materials used in the study were upland rice seeds of several varieties, namely IPB 9G, IPB 3S, LIPI Go 1, and LIPI Go 2. IPB 9G and IPB 3S seeds were obtained from the Department of Agronomy and Horticulture, Faculty of Agriculture, IPB. In contrast, the LIPI Go 1 and LIPI Go 2 varieties were obtained from LIPI.

2.3. Research Procedure

The design used was a factorial Completely Randomized Design (CRD) consisting of the Solomon sengon type F2 tree spacing factor and the rice variety factor. The tree spacing of sengon in this study was 1.5 m × 1.5 m and 1.5 m × 3.0 m. The rice varieties in this study were LIPI Go 1, LIPI Go 2, IPB 3S, and IPB 9G rice varieties. The experimental design model for the factorial RAL is as follows:

$$Yijk = \mu_i + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \quad (1)$$

where Y_{ijk} is the response of sengon and rice growth on the *i* level tree spacing factor; rice variety factors at the *j* level and the *k* replication, μ is the general average value, α_i is the effect of the treatment of the tree spacing factor at the *i*, β_j is the effect of the treatment of rice varieties at the *j*, $(\alpha\beta)_{ij}$ is the effect of the interaction between the *i* level tree spacing factor and the variety factor of *j* rice, ε_{ijk} is the random effect on the *i* level tree spacing factor, the third rice variety factor *j* and *k* repetition, *i* is tree spacing treatment, *j* is rice variety treatment, and *k* is the repetition (1, 2, and 3).

Land preparation was done by cleaning from weeds with mechanical, weeding, applying manure and compost (Hartoyo et al. 2014). Fertilizer application was intended to increase soil fertility. The breaking of rice seed dormancy was done by soaking the seeds in POH for 24 h before planting. Rice was planted at a distance between sengon plantings, namely 1.5 m × 1.5 m (J1) and 1.5 m × 3 m (J2) (**Fig. 2**). The number of treatments observed was 8 treatments with 3 replications, so each treatment contained 3 plots (J1V1: 3 plots, J1V2: 3 plots, J2V4: 3 plots). The research area had an area of 1,500 m² and in that land grows sengon trees aged 14 months old. The sengon used in this study was the descent of Solomon sengon type F2. The sengon trees were arranged in 30 m long lines. There were 21 trees in each lane with a distance between trees of 1.5 m × 1.5 m (J1) and 1.5 m × 3 m (J2). Rice was planted in a space in the research area, namely, between sengon trees on each lane (J1 and J2). The distance between rice planting holes was 25 m × 25 cm (Hambali and Lubis 2015). The planting hole was made with a depth of 2-3 cm. Five (5) rice seeds were planted in one planting hole. The planting holes were arranged into plots where each plot contained 16 planting holes on J1 and 64 planting holes on J2 with 3 replications so that 4,800 seeds were needed.

The fertilizers given were POH and NPK fertilizers. POH was given at a dose of 7-8 l/ha. NPK fertilizer was applied on upland rice at 10 and 20 DAP. The NPK fertilizer given at 10 DAP (days after planting) was 15 kg of urea, 15 kg of SP 36, and 15 kg of KCl, then 15 kg of urea was given at 20 DAP. Fertilization was done by sprinkling fertilizer according to the dose on a 2-3 cm wide array made between rice.

Maintenance carried out in this study were watering, replanting, weeding, and controlling pests and diseases (Senjaya et al. 2018). Embroidery was carried out for ten days after planting holes where the seeds died or did not grow. Pest control was done chemically and mechanically.

Chemical control was carried out by giving furadan and insecticide with fipronil's active ingredient. The dose of Furadan was 16 kg/ha and 1 ml insecticide for 1-liter water. For pest control, insecticides were used with an active ingredient of 3% carbofuran to eradicate termites, the active ingredient deltamethrin to eradicate leaf caterpillars, and fipronil 50 gL^{-1} to eradicate bugs. Insecticides were given when the rice panicles grew to control the pest.

Upland rice was harvested when the rice condition was 85% physiologically ripe, which was indicated by the yellowing of the rice. This research was conducted from October 2019 to February 2020 (five months). Harvesting was done by cutting the rice base and threshing the rice that produces grain (Senjaya et al. 2018).

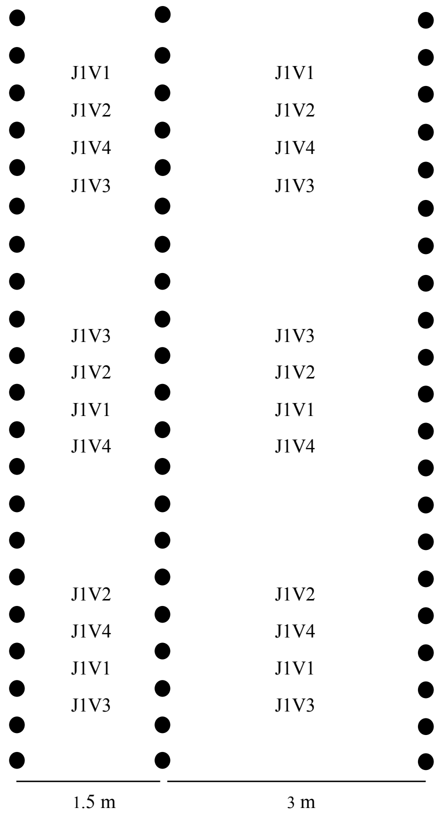

Fig. 2. The planting designs.

The growth of sengon observed was height, diameter, and canopy area. Measurements were made at the beginning, middle, and end of the study. Data collection for upland rice was carried out by observing the growth and yield of harvests whose measurements were carried out after 45 DAP and at harvest time. Parameters observed include height, number of tillers, number of productive tillers, panicle length, the weight of pithy grain, weight of empty grain, and productivity (Fitria and Ali 2014). Environmental data obtained in the research area include soil, light intensity, air temperature, humidity, and rainfall.

2.4. Data Analysis

Data were analyzed statistically using the analysis of variance (ANOVA) test with a level of 5% to see the effect of treatment on several parameters tested and the Duncan test at the 5% level for parameters that had a significantly different effect.

3. Results and Discussion

3.1. The Growth of Solomon Sengon

The combination of sengon and upland rice in agroforestry systems caused interactions between components that affected the growth and production. Tree spacing is one of the silvicultural techniques that can minimize crop competition. Each type of plant had a different optimal spacing.

Table 1. The effect of tree spacing on the growth of Solomon sengon

Treatment	Parameters
Height (m)	0.02*
Diameter (cm)	0.43^{ns}
Canopy area (m^2)	0.35^{ns}

Notes: * The treatment has a significant effect at the 95% confidence interval. ns = The treatment has no significant effect at the 95% confidence interval.

Tree spacing only had a significant effect on height and had no significant effect on the diameter and canopy area of Solomon sengon (**Table 1; Table 2**). This tendency indicates that at the age of 14 months old, there has not been competition for nutrients, water, or sunlight for the growth of diameter and canopy area at J1 and J2 planting distances (Widiyanto et al. 2013). In general, the growth in height, diameter, and canopy area achieved by sengon tends to have a greater value at wider spacing than dense spacing (Kosasih and Mindawati 2011).

Table 2. The results of the Duncan test on height, diameter, and canopy area of Solomon sengon

Variable	J1	J2
Height	9.55b	10.41a
Diameter	6.85	7.16
Canopy area	13.07	13.17

Notes: J1= 1.5 m × 1.5 m; J2= 1.5 m × 3 m.

Solomon sengon at J2 was higher than sengon at closer spacing (J1) (**Fig. 3**, **Table 2**). It was because tree spacing affected the light intensity and nutrient availability. The wider the spacing, the smaller number of trees per unit area, so that the competition between plants is lower (Widiyanto et al. 2013).

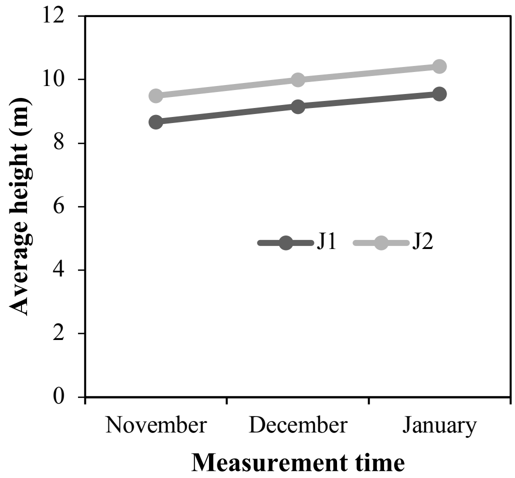

Fig. 3. The height of Solomon sengon at J1 and J2 (Notes: J1= 1.5 m × 1.5 m; J2= 1.5 m × 3 m).

The height of sengon in this study increased by an average of 0.43 m at J1 and 0.45 m at J2 every month. According to Krisnawati et al. (2011), the average height of sengon aged 2 to 5 years old increases by 0.33 m per month. It showed that the Solomon sengon in the study grew faster than sengon in general. The faster growth in height responds to the competition between these two kinds of sengon for sunlight. This tendency supported the variance results, which showed the effect of spacing on sengon height (**Table 1**).

On average, the diameter of sengon in the research area increased by 0.2 cm every month. The diameter of Solomon sengon at J2 was larger than Solomon sengon at a closer spacing (J1) (**Fig. 4; Table 2**). The average diameter of sengon at the end of the observation reached 6.85 cm at J1 and 7.15 cm at J2. The increase in diameter from the middle to the end of the measurement was smaller because the rice began to form panicles, requiring more nutrients.

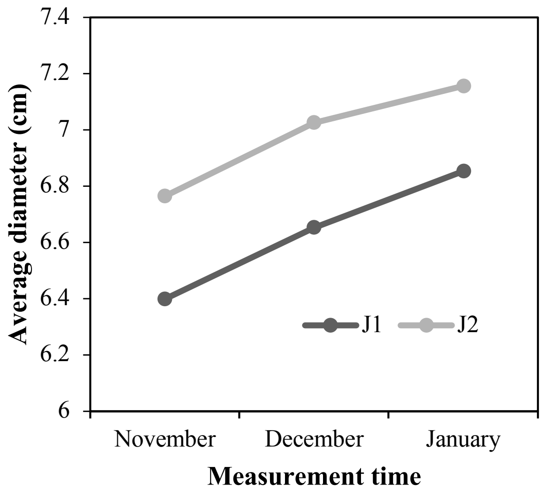

Fig. 4. Diameter of Solomon sengon at J1 and J2 (Notes: J1 = 1.5 m × 1.5 m; J2 =1.5 m × 3 m).

The tree canopy was one of the factors that affected the growth and yield of intercropping plants. The area of the tree canopy represented the level of land cover. The increasing age of sengon also causes its roots to develop, both horizontally and vertically, thereby increasing competition between plant roots (Ikhfan and Wijayanto 2019). Plant roots play an essential role in absorbing water and nutrients from the soil (Wijayanto and Hidayanthi 2012). Sopacua et al. (2021) reported that sengon roots indirectly absorb the nutrients provided to rice.

Based on observations, it was known that the average canopy area of sengon at J2 (13.17 m^2) was greater than that of Solomon at J1 (13.07 m^2) **(Fig. 5; Table 2)**. The wider the spacing of Solomon sengon, the greater the space for plant growth. A larger canopy area can capture more sunlight to enlarge the photosynthesis process, further increasing plant growth. In addition, larger trees with wider crowns can better compete for light, nutrients, and water (Wijayanto and Nurunnajah 2012).

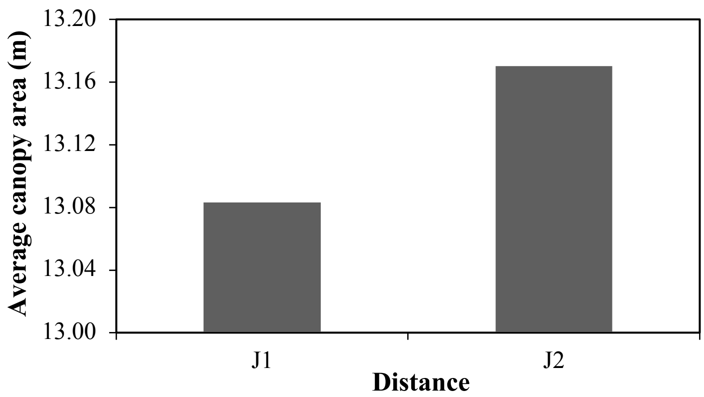

Fig. 5. The area of the Solomon sengon crown at J1 and J2 (Notes: J1 = 1.5 m × 1.5 m; J2 = 1.5 m × 3 m).

3.2. Upland Rice Growth and Productivity

A sound agroforestry system will lead to positive interactions between the constituent plant components, indicated by the increased growth and production of staple and intercropping plants. Therefore, the growth and yield of several upland rice varieties were measured to determine the effect of their interaction with Solomon sengon. Rice varieties affected the number of tillers, panicle length, and the number of productive tillers. However, varieties did not affect rice height, the weight of pithy grain, the weight of empty grain, and rice productivity (**Table 3**). Meanwhile, sengon spacing treatment did not affect all rice parameters at a 95% confidence interval. The treatment of rice varieties and spacing of sengon also did not affect the growth and yield of rice.

Table 3. The effect of spacing between sengon and rice varieties on rice growth and yield

Parameter	Treatment		
	Varieties	**Distance**	**Interaction of variety and distance**
Rice height (cm)	0.5^{ns}	0.45^{ns}	0.82^{ns}
Number of tillers	0.04^{*}	0.10^{ns}	0.65^{ns}
Panicle length (cm)	0.00^{*}	0.44^{ns}	0.20^{ns}
Number of productive tillers	0.01^{*}	0.27^{ns}	0.15^{ns}
Weight of pithy grain (g)	0.54^{ns}	0.39^{ns}	0.51^{ns}
The weight of empty grain (g)	0.38^{ns}	0.66^{ns}	0.81^{ns}
Productivity (ton/ha)	0.15^{ns}	0.48^{ns}	0.42^{ns}

Notes: * The treatment has a significant effect on the 95% confidence interval, ns = The treatment has no significant effect on the 95% confidence interval.

Rice varieties and sengon spacing affected all the parameters tested except for the empty grain weight parameter (Azizah 2019). It was due to the difference in the age of the sengon studied. In the research area, the 14-month-old sengon canopy had grown wider, reducing the intensity of light received by the rice. The shade of sengon in agroforestry affects the growth and yields (Hartoyo et al. 2014). The low light intensity received by upland rice will affect the morphology and physiology of rice. Therefore, upland rice developed on land with limited light requires a strategy to achieve successful cultivation. Selection of shade-tolerant rice varieties can be one of the strategies (Caron et al. 2019; Wang et al. 2015). In addition to light intensity, a factor that causes low rice yields in the research area is the pest *Walang Sangit* (*Leptocorisa oratorius*).

Walang Sangit attacking in high intensity can reduce crop yields by 10-40% and even reach 100% in very heavy attacks (BBPADI 2015).

Table 3 shows that the LIPI Go 2 variety is the variety that had the lowest number of tillers, panicle length, and the number of productive tillers. It might be caused by differences in the adaptability of each rice variety in the research area. IPB 3S is a variety that generally had the best growth and yield in the research area. According to LPPM IPB (2016), IPB 3S is lowland rice with drought tolerance. High rainfall during the study (> 200 mm/month) was suspected of causing IPB 3S rice to grow better. Sopacua et al. (2021) have reported the growth of various provenances of 16-month-old sengon (Solomon type F1, Solomon type F2, and local) and upland rice (LIPI Go 1, LIPI Go 2, IPB 3S, and IPB 9S) that were planted under them. The results show that only IPB 3S and IPB 9G varieties yielded seed.

Table 4. The results of the Duncan test on rice varieties

Parameter	LIPI Go 1	LIPI Go 2	IPB 3S	IPB 9G
Number of tillers	3.21a	2.16b	3.37a	3.08ab
Panicle length (cm)	7.18bc	2.07c	8.59ab	14.26a
Number of productive tillers	2.42a	0.54b	2,69a	3.04a

Note: Different letters in the same row indicate if the treatment has a different effect.

The parameters measured to determine rice growth were plant height and the number of tillers. According to Azizah (2019), the varieties LIPI Go 1 and LIPI Go 2 have a higher plant height than IPB 3 ES and IPB 9G. The highest average rice height at J1 was LIPI Go 1 (62.50 cm), and the shortest variety was IPB 3S (47.91 cm). Meanwhile, the highest rice at J2 is LIPI Go 2 (60.87 cm), and the shortest variety is IPB 3S (43.75 cm). Rice grown under the stands of Solomon sengon at J2 had a shorter plant height than rice grown under Solomon sengon at J1 (**Fig. 6**). This is because rice under Solomon sengon stands at J1 obtained sufficient shade from the sengon canopy. The amount of shade affected the intensity of light received by rice plants. The sengon canopy blocked sunlight caused the rice to experience etiolation symptoms. Etiolation occurred due to the activity of the hormone auxin, which caused the apical part of the plant to experience the most active growth. These plants grow to look for light to maximize photosynthesis (Alridiwirsah et al. 2015). Symptoms of etiolation cause laying down, reducing plant growth and crop yields (Senjaya et al. 2018).

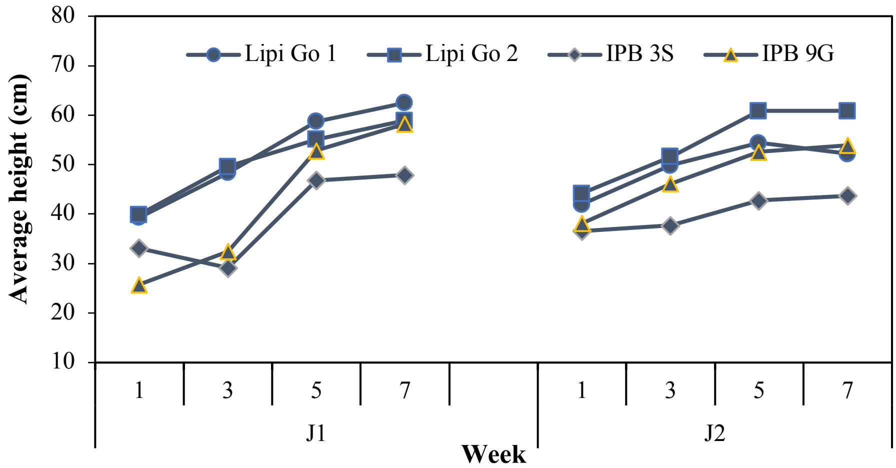

Fig. 6. Average rice height at J1 and J2 (Notes: J1 = 1.5 m × 1.5 m; J2 = 1.5 m × 3 m).

Each rice variety has different abilities in forming tillers (Hambali and Lubis 2015). **Fig. 6** shows that at J1, the IPB 3S variety had the highest number of tillers, and the LIPI Go 1 variety had the least number of tillers at the end of the observation. The highest number of tillers at J2 was the LIPI Go 1 variety, and the least number of tillers was the LIPI Go 2 variety. This tendency indicated that the LIPI Go 1 variety in the study was the most sensitive variety to shade. These varieties can produce many tillers at a certain level of shade. Alridiwirsah et al. (2015) stated that the low number of rice tillers with high shade is because most of the plant photosynthesis results are used to increase plant height.

The number of rice tillers in the study did not always increase. The maximum number of tillers was reached when the rice was 50-60 DAP, and then it decreased due to weak growth and death. It happened because the results of plant photosynthesis are mainly used for generative growth (Dewi et al. 2014). It is what caused the graph in **Fig. 7** to fluctuate.

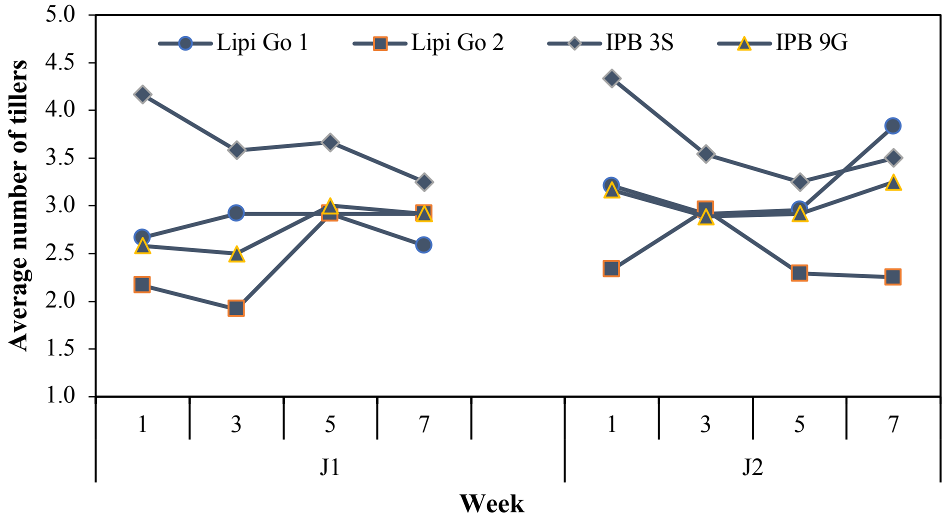

Fig. 7. The average rice tillers at J1 and J2 (Notes: J1 = 1.5 m × 1.5 m; J2 =1.5 m × 3 m).

3.3. Environmental Conditions

The growth and yield of rice plants are influenced by environmental factors such as soil properties, light intensity, temperature and humidity, and rainfall. The soil analysis results showed that upland rice cultivation could increase the pH, C-organic, and N-total content in the soil. The increase is due to the provision of POH, compost, and manure. Agroforestry systems also produce more and different litters, resulting in more organic matter.

Rice in the research area got a low light intensity, namely 1212.88 lux at J1 and 1304.37 lux at J2. Upland rice under 50% shade or around 26,000 lux has low productivity (Alridiwirsah et al. 2015; Handriawan et al. 2016). The intensity of light will affect the temperature and humidity of the air. The temperature under the sengon stand in the study was 28.63°C, and the humidity was 72.67%. The sunlight intensity from the rice will affect its growth and yield (Nuraida et al. 2020; Wang et al. 2015). In conditions of low light intensity, the activity of enzymes that play a role in the photosynthesis process is inhibited. It causes the plant source organs to be unable to provide sufficient assimilation for the needs of growth and filling of rice grains (Liu et al. 2014).

Upland rice is a type that is tolerant to drought, but lack of water can cause growth disorders which can further reduce production. Drought stress parameters have a significant effect on the parameters of plant growth rate at 14-30 DAP (Day After Planting), the relative growth rate for plants at 14-30 DAP, plant height at Weeks 8 and 15, number of leaves at Week 8 and 15, leaf chlorophyll index in the generative phase, number of productive tillers and tillers, number of seeds and seed weight (Fadhilah et al. 2021). In addition, drought will disrupt metabolic processes of plants, such as the inhibition of nutrient absorption, inhibition of cell division and enlargement, decreased enzyme activity, and the closure of stomata, so that the growth and development of plants become stunted (Supriyanto 2013). One source of water that can support rice growth is rainwater. Therefore, rainfall will determine the success of rice growth and yields. According to the BMKG (2020), rainfall from the beginning of planting (October) to harvesting (February) was 381.90, 330.10, 552.80, 383.50, and 510 mm/month. Sidauruk (2015) explained that rainfall suitable for upland rice growth is more than 200 mm/month for at least four consecutive months.

4. Conclusions

Solomon sengon with a tree spacing of 1.5 m × 3 m had higher growth than sengon with a tree spacing of 1.5 m × 1.5 m. The varieties of LIPI Go 1, LIPI Go 2, IPB 9G, and IPB 3S under 14-month-old Solomon sengon stands with a tree spacing of 1.5 m × 3 m have higher productivity than rice under sengon with a tree spacing of 1.5 m × 1.5 m. Among all rice varieties examined in this research, rice variety IPB 3S has the highest productivity. Sengon and rice agroforestry systems are an alternative to support national wood and food needs.

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