Growth and yield of rubber tree (hevea brasiliensis) clon pb260 from different of weed ecosystem

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Growth and Yield of Rubber Tree (*Hevea brasiliensis*) Clon PB260 from Different of Weed Ecosystem

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Abstract

Community rubber tree plantations in Indonesia are the main source of national natural rubber production and a source of income for farmers. Low rubber price has limit farmers' ability to control weeds using herbicides and mechanically. This situation causes the formation of three ecosystem conditions based on the level of weed growth, namely well-maintained plantations, shrubs on rubber plantations, and forests on rubber plantations. Therefore, this research studied and compared tree growth and rubber yields from three of weed ecosystems. Field research was designed using a Randomized Block Design (RBD) with three ecosystems as treatments and three replications. Three plots of size (10 m x 10 m) were made for each weed ecosystem in the rubber plantation, and three sampling rubber trees were selected so that the number of rubber trees observed was 9 trees for each ecosystem. Based on ANOVA, it showed that the weed ecosystem had a significant effect on the yield of rubber trees. Trees maintained well had the highest lumps (537 kg/6monts/ha), not significantly different from forested rubber trees (478 kg/6monts/ha. The dominant weeds in each ecosystem were Hevea brasiliensis and Acacia auriculiformis. Forested plantations had higher yields relatively more stable, producing lumps per week of 107.55 g/tree to 188.15 g/tree.

Keywords : Hevea brasiliensis; Growth; Latex; Weeds; PB260.

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1. Introduction

The largest rubber plantation (Hevea brasiliensis Müell. Arg.) in Indonesia is located on South Sumatra Province, and in 2021 it reached around 892.11 thousand hectares [1]. Most of these are community rubber plantations with low latex production, but they are a source of income for the people and have an impact on reducing poverty levels [2], [3]. Low natural rubber prices have an impact on reducing farmers' income, causing a decrease in farmers' investment ability and even land conversion to other crops that farmers consider more profitable [4]. Increasing rubber latex yields must be through proper management and requires various production inputs such as fertilization, pest and weed control [5], [6]. The cost of wages and materials for weed control in plantations is higher when the immature rubber plants because the weed population is more [7], [8]. Based on their size, weeds with larger shapes cause more competition with rubber plants. Weeds around rubber plants cause competition for nutrients and weeds in the form of poles and trees that have an equal or higher height will inhibit the growth of tree crowns and the height of rubber plants [9]. In these conditions, rubber trees will experience disturbances in the form of competition for nutrients, water, growing space, and blocked light. According to Guzzo et al., (2014) [10], this condition can inhibit the growth of plant height, stem dry mass, number of leaves, and stem diameter by 99%, 82%, 72%, and 63%, respectively. In addition, weeds of lower size with high

density are also detrimental because they can suppress the dry weight of plant roots and the number of leaves [11]. Currently, many rubber plantations are filled with shrubs and even some have taken the form of rubber forests [12].

The PB260 clone is a latex-producing rubber that is characterized by high yield production of more than 1.5 tons/ha/year [13], [14] and has stable latex yields in conditions of less fertilizer, minimal weed control and little pesticide application [15]. However, this potential is difficult to achieve if inappropriate weed management and production facilities are not met. Differences of farmers' ability to carry out maintenance led to the development of various rubber weed ecosystems based on the stage of vegetation. Therefore, in this study, the ecosystem of community rubber plantations can be grouped into three conditions, namely well-maintained rubber plantations, shrub rubber plantations, and forested rubber plantations. Yield components and growth of rubber trees need to be studied and compared to determine the effects of growing in the three weed ecosystems.

2. Materials and Methods

2.1 Time and Place

The research was conducted at the Rubber Research Experimental Plantation, Faculty of Agriculture, Sriwijaya University, Indralaya. Ogan Ilir, South Sumatra. The rubber plantation observed was with about 14 years old plants. Weed ecosystems were selected in different plantation blocks according to weed conditions. Location coordinates based on UTM - DGN95, namely well-maintained plantation (48 S 459676 E, 9643326 N), shrubs rubber plantations (48 S 459574 E, 9642973 N) and forested rubber plantations (48 S 475149 E, 9612000 N). The research was conducted from January to July 2023 with a total of 18 weeks of observation.

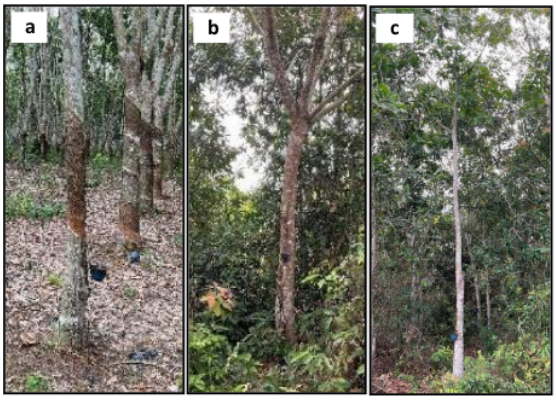


Figure 1. Well-maintained plantation (a); Shrubs rubber plantation (b); Forested rubber plantation (c).

2.2 Research Methods

The weed ecosystem was set as a treatment consisting of 3 types of weed vegetation, namely well-maintained rubber plantation (a) shrubs rubber plantation (b), and forested rubber plantation (c). Data processing of rubber results using Analysis of Variance (ANOVA) data from a Randomized Block Design design using the help of *Microsoft Office™ 2019©® VBA add-in computer application (DSAASTAT ver 1.514)* [16]. Each group in the ecosystem has 3 plots with a width of 10 m x10 m, so there are a total of 9 observation plots. One plot contained 3 rubber trees as replicates so that a total of 27 rubber trees were observed.

Data collection was carried out with the initial determination of the location of rubber observation plots by setting up ropes and marking coordinate locations with the help of *SmartGPS Avenza Maps™* software. Rubber trees were tapped using the 1/2S d/2 system. Then, lumps were observed weekly by weighing the weight of the lump using a digital scale with an accuracy of 1 g. Measurement of crown width and height was assisted with a stick and measuring tape.

3. Results and Discussion

3.1. Weed Structure and Composition

Weed ecosystems formed as a result of differences in weed management have their own characteristics based on the ratio of the growth rate of rubber trees to surrounding weeds and vice versa. The highest weed canopy is found in forested plantations with the type of tree growth level reaching a height of 1.04 m higher than some rubber trees. Dimensions of rubber trees with the widest canopy are in shrub plantation around 0.5-0.6 m. while the circumference of the rubber trunk tends not to differ. The environmental conditions of the three ecosystems can be seen in Table 1.

3.2 Rubber Yield

The rubber latex collected in *lump* form was then weighed weekly, then compiled into a production rate in Figure 2 below. The highest average yield from weekly sample observations was obtained in March the first week at 196.88 g/tree/week, and the lowest in June the first week at 83.29 g/tree/week.

Table 1. Typology of Rubber Plantation Weeds in Three Ecosystems

Weed Ecosystem Type	Canopy Height	Canopy Height	Forested Rubber plantation	Rubber Tree Girth	Dominant Weeds
	……..…….…. m ……..……			……cm……	
Well-Maintained Rubber Plantation	1,5	9,1	3,5	61,25	*Hevea brasiliensis*
Shrubs Rubber Plantation	4	8,45	5,5	61,5	*Melastoma mala-batricum*
Forested Rubber Plantation	10,4	10,4	2,5	54,5	*Acacia auriculiformis*

The average results of rubber *lumps* are significantly different with F value greater than F-Table at the 5% level for weed variables. Then proceed with post-hoc test using the method of Least Significant Difference (LSD) 0.05 to determine the significant differences in the group mean of the 3 Rubber Plantation Weed Ecosystems. Well-maintained plantations do not have a mean yield that is not significantly different with forested plantations can be seen in Tables 2 and 3 below.

Tabel 2. F-Value and Coefficient of Variance of Mean *Lump* Yield.

Variabel	F-Hitung	ProbF	Coefficient of Variation (%)
Blocks	3,83^{ns}		
Gulma	11,03*	0,02	
Residual			16,65
Total			
F 0,05 = 6,94			
F 0,01 =18,00			

Description: * = significant effect (5% level);
ns = non-significant effect.

Table 3. Post-hoc Test of Least Significant Difference (LSD) of Average Lumps Yield per tree in Three Weed Ecosystems of Rubber Plantation.

Weed Ecosystem Type	Rubber *Lump* (g/tree/week)	
Well-Maintained Rubber Plantation	162,58	a
Forested Rubber Plantation	144,84	a
Shrubs Rubber Plantation	91,65	b
LSD 0,05	30,53	

Description: letters with the same notation mean not significant

Lump weight results collected based on weekly production of rubber trees (Table 3) so that the highest estimate of 88.34 kg / ha / month for well-maintained plantations to be the highest yield and the lowest shrubs rubber plantations with a difference of 8.68 kg / ha / month. Estimated rubber lump per hectare obtained in the 6-month period is about 530.05 kg for well-maintained rubber to have the highest yield.

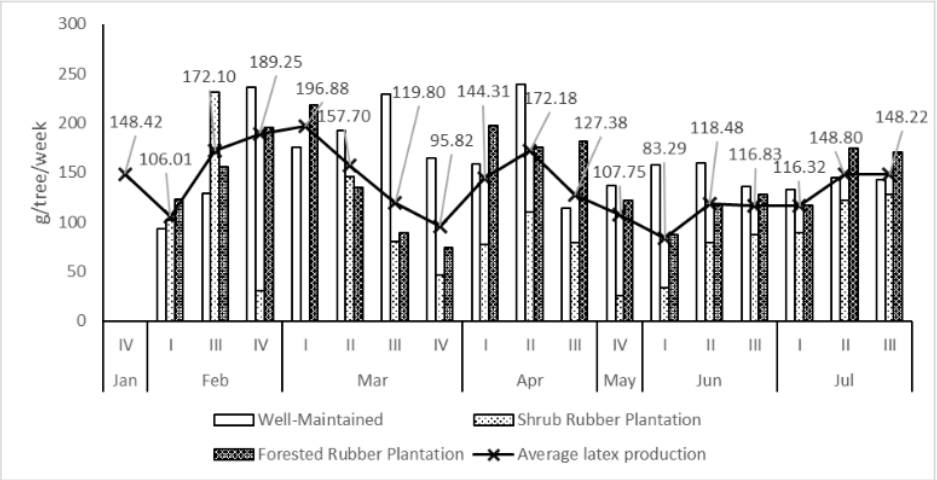


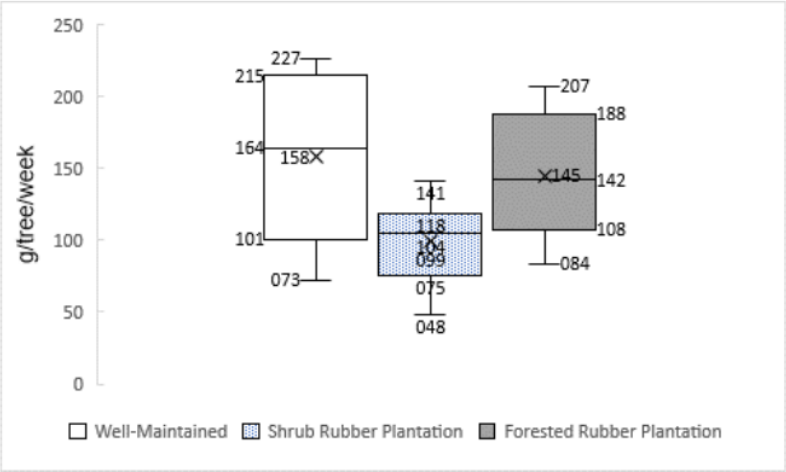
Figure 2. Weekly Rubber Lump Production Rate in Three Weed Ecosystems.

Table 4. Estimation of Rubber Lumps Yield per hectare during Six Months of Observation in Three Weed Ecosystems of Rubber Plantations.

Weed Ecosystem Type	Estimated 6-month Lump Yield*
	.....kg/ha……
Well-Maintained Rubber Plantation	536,51
Shrubs Rubber Plantation	302,43
Forested RubberPlantation	477,97

* Estimated yield of 550 trees per ha

Shrub rubber plantation has the lowest mean. Based on the distribution of the data, most of the observations were in Quartile 1 (Q1) of the other 2 types of weed conditions (Figure 3). Its data showed the smallest value at 48.25 g/tree/week. Then, the well-maintained rubber plantation had a yield up to 226.56 g/tree/week. Forested rubber plantations have a relatively more stable yield with most having a production of 107.55 to 188.15 g/tree/week.



Description: The box-plot is divided into Quartiles 1 to 4 (Q1-Q4) of the lowest to highest observed data.
Figure 3. Distribution of rubber lump yields for Three Rubber Plantation Weed Ecosystems.

Cultivation practices have affected the original conditions of the surrounding abiotic environment. The limited resources of farmers cause selective control of weeds that are considered a nuisance. Different weed controls cause different weed growth rates. The abiotic environment affects the shape and morphology depending on the age of the ecosystem formed as can be seen in Table 1. Plantations with less maintenance cause weeds to grow to the same height as rubber trees which will then relate to the ability to infiltrate light. Rubber tree morphology has different characteristics in each type of weed condition. The height and width of the canopy of rubber trees are influenced by external factors including agroclimate and land management [17].

The dominant weed in the well-maintained plantation ecosystem is *Hevea brasiliensis* because it grows from seeds that fall from trees that bear fruit and have not been controlled. Shrubs plantations are dominated by *Melastoma malabatricum* which grows tightly between rubber trees that are only cleared for tapping lines. Forested plantations are overgrown with *Acacia auriculiformis* species that have rivaled the height of rubber trees so that they compete in space and light capture areas. The competence of nutrient competition of rubber trees is also influenced by the type of rival plants [18].

The well-maintained plantation had the highest *lump* yield at an estimated yield of 550 trees per ha for 6 months at 536.51 kg/ha but not significantly different at the 5% level from the forested plantation with a difference of 52.08 kg/ha with a yield of 477.97 kg/ha. The rate of latex production (Figure 2) in the well-maintained rubber plantation ecosystem has the largest portion of the total average yield of the week under observation followed by the forested plantation ecosystems in turn. The well-maintained plantation ecosystems had less competition with weeds, but weed control with herbicides increased nutrient leaching [19]. Plantations without weed control are able to maintain soil, organic matter and nutrient conservation [20]. Organic matter that accumulates on the soil surface becomes a natural mulch that improves soil properties such as temperature, moisture content, mass density, aggregate stability [21]. Shrubs plantations had the lowest yield, in the *box-*

plot (Figure 3) most values were in the first quartile (Q1) of well-maintained plantations.

Shrubs plantation had the lowest yield, smaller than the Quartile 1 (Q1) yield of the Forested Plantation (Figure 3) with an estimated 302.43 kg/ha. Nutrient competition began to take effect from weeds growing around the rubber tree up to a distance of 100 cm [22]. Shrubs plantation ecosystems rarely have the highest yields in the observation sample plots, in addition, many trees were found to be affected by Tapping Panel Dryness (TPD) which reduced plantation yields. TPD can be caused by disruption of nutrient uptake in the latex and bark tissue [23]. Weeds in shrubs plantations grow well in comparison to weeds in forested rubber plantations which have limited growth rates as a result of shading from canopy trees and probably below-ground competition [24].

Forested plantations have relatively stable latex production of 107.55 g to 188.15 g per tree/week in Q2 and Q3. Disturbances in the form of weather and climate changes have an influence on the growth and yield of rubber trees. Temperature and humidity are affected by the amount of light that penetrates the rubber plant canopy [25]. The flow of too much rainwater can pour over the storage bowls such as in the fourth week of February and the fourth week of March, thus disrupting the process of coagulation the latex and damaging its quality. However, weekly lump yields in the plantation are dependent on rainfall intensity and rainy days towards achieving optimal productivity of rubber trees [26]. Sufficient rainfall intensity is needed for the process of absorption and availability of water as in April the second week to the fourth week the rate of rubber yield decreased and then rose in June the first week to July the third week.

Well-maintained plantations that are under physical stress in the form of tapping and drought tend to be weather-dependent, while shrubs plantations tend to be controlled by their weed structure. Forested plantation ecosystems have high biodiversity and stable abiotic factors [27]. Low diversity and physically stressed tend to be dependent on physical components such as weather but otherwise will tend to be biologically controlled [28]. Forested plantations have a relatively more stable yield against weather stress with most having a production of 107.55 to 188.15 g/tree/week.

4. Conclusion

The well-maintained plantation ecosystem had the highest lump yield at an estimated yield of 550 trees per ha for 6 months at 536.51 kg/ha but was not significantly different from the forested plantation with a yield of 477.97 kg/ha at an estimated yield of 550 trees per ha for 6 months. Forested plantations had relatively more stable yields of 107.55 to 188.15 g/tree/week. The shrubs plantation had the lowest yield with an estimated 302.43 kg/ha as it tended to be controlled by its weed structure. The dominating weed in the well-maintained plantations ecosystem is *Hevea brasiliensis,* shrubs rubber plantations are dominated by *Melastoma malabatricum* and forested rubber plantations are overgrown with *Acacia auriculiformis*.

5. Acknowledgement

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