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Efficient Exploitation System in Rubber (Hevea brasiliensis Muell. Arg) Clone PB 260 Plantation in Simalungun Sumatera Utara Indonesia

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Abstract Indonesia as a producer of natural rubber is still below Thailand, which has an area smaller than Indonesia. This is because Indonesian rubber plantations are dominated by smallholder rubber plantations whose exploitation systems do not comply with regulations. Therefore, the aim of the research was to increase the productivity of the PB 260 clone through the length of the half-spiral (S2) and quarter (S4) tapping grooves and the administration of liquid stimulants. This research was carried out at Afdeling II PT. Perkebunan Nusantara III Kebun Bandar Betsy, Bandar Huluan II District, Simalungun Regency, North Sumatra. Non Factorial Randomized Block Design Research Method as a combination treatment of an exploitation system with two levels (S2) and (S4) and administration of liquid stimulants repeated three times. The research results showed that S4 treatment had a higher latex yield than S2. The treatment given did not affect the physiology of latex clone PB 260 and was still within optimum limits. S4 treatment was more efficient in increasing the latex yield of 16-year-old PB 260 clones.

Keywords Hevea Brasiliensis, Clone PB 260, Half and Quarter -Spiral, Latex Quality

1. Introduction

The largest natural rubber producing country is Indonesia, which however, only ranks second after Thailand which has a smaller area. This is because Indonesia has a larger area of smallholder rubber plantations, namely a total area of 85%, 9% private and 6% State. But in terms of cultivation of smallholder rubber plantations, it is not in accordance with the rules, especially the exploitation system. This is what causes Indonesia's natural rubber productivity is still low [1].

Smallholder rubber farmers have not paid attention to common problems in the nature of each clone and exploitation system. Each clone has different characters, so the tapping and provision of stimulants are also different to maintain a longer economic life in rubber plants [2].

The exploitation system that will be applied to rubber plants needs to be seen from the metabolic rate, tapping interval, plant age and stimulant concentration, so that plant productivity can be increased and the economic life of the plant becomes longer. Tapping interval of 3 days once in tapping (d3), (d4), (d5), tapping time in the morning, afternoon, evening and tapping furrow length S4 (a quarter), and S2 (half) affect physiology, high and low latex yield, and economic life of the plant [3].

Setting the length of the tapping groove half the circumference of the trunk (S2), a quarter (S4), an eighth (S8) and the use of stimulants, needs to be considered because these techniques have a major influence on the efficient use of the tapping field and increasing latex yield productivity. This is in line with the research of Pulchérie et al. [4] on PB 260 clone S4 tapping towards the top that can increase the productivity of rubber plants. Moussa et al. [5] stated the appropriate exploitation system for slow, moderate and fast metabolism S/2 d3 6d/7 ET2.5% Pa1(1) 4/y.

Application of stimulants with high concentrations (3.5-5%) is recommended with low intensity tapping, namely four days tapping (d4) or five days tapping (d5). Atminingsih [6] recommended the use of high concentration stimulants (5%) with a tapping intensity of once every four days (d4). Research results on stimulant concentration (Darojat, et al. [7]; Yu et al. [8]; Krisnarini et al. [9]; Adriyanto et al. [10]) stated that with the concentration of liquid stimulant etephon 1% and 2% applied to 7-year-old plants using multiclones (PB 260, PB 340, PB 330, IRR 104, IRR 5, IRR 112, IRR 118, and BPM 1) with tapping interval d3 can increase latex yield 44.11%, 2% concentration increases yield 48.10%.

This study uses a fast metabolism clone, namely PB 260 clone with advantages including the development of stem circumference size when the plant is before and ready to be tapped 60-65 cm, resistant to leaf diseases. The peak latex yield at the beginning of tapping is 5-8 years old with a fairly high initial potential, namely an average latex yield of 2,107 kg/ha/year [2].

Research that has been done using S2 and tapped every three days (d3) with a stimulant concentration of 2.5% with high metabolism clones, here researchers used the length of the tapping groove S2 and S4 and tapped every four days (d4) with a concentration of 3.5% on the 16-year-old PB 260 clone. Previous research using slow metabolism clones, namely RRIM 921 and GT 1 clones, on GT 1 clones aged 19 years the exploitation system S/4 d3 ET 2.5% can increase the productivity of rubber plants [11], [12].

Based on the problem, this study aims to streamline the use of tapping fields to increase the productivity of latex yields on 16-year-old PB 260 clones with the treatment of quarter (S4) and half (S2) tapping grooves with 3.5% stimulant.

2. Materials and Methods

2.1. Description of Research Location

This research was carried out at Afdeling II PT. Perkebunan Nusantara III Kebun Bandar Betsy, Bandar Huluan II District, Simalungun Regency, North Sumatra with an altitude of 900 meters above sea level, coordinates 3012”15”N 99015”38”E. Physiological analysis was carried out at the Sungai Putih Rubber Research Institute Laboratory, Deli Serdang.

2.2. Research Methods

The research method used a Non-factorial Randomized Block Design (RBD) with three replications of the treatment combination of tapping groove length and liquid stimulant which consisted of 2 levels, namely:

S2 d4 ET 3.5%/15d (the length of the tapping groove half the circumference of the stem is tapped once every 4 days and the concentration of liquid stimulant ethepon 3.5% is given once every 15 days) (Figure 1).

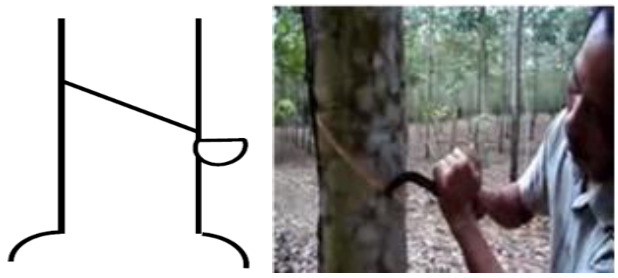

Figure 1. Tapping S2 Personal Source, 2015

S4 d4 ET 3.5%/15d (tapping furrow length of a quarter of the trunk circumference is tapped once every 4 days, and the concentration of liquid stimulant ethepon 3.5% is given once every 15 days) (Figure 2).

Figure 2. Tapping S4 Personal Source, 2015

Observational Variable

Each treatment was repeated three times and each replication for the control treatment used three trees and five trees for the stimulant application so that the total plants used were 150 trees.

The active stimulant ingredient used is etefon (2-chloroethyl phosphonic acid). The dose of ethefon given to plants is 0.91-0.99 $g^{-1}t$ using the groove application method. Stimulants are given after 4 tapping slices according to a tapping interval of four days (d4) with the condition that the number of leaves is ± 50% -60%. The tapping was carried out at 06.30-10.30 AM and the latex results were collected at 12.00 AM.

Observation of latex results was carried out according to the tapping frequency, namely d4 (tapping once every four days). Variable observation of dry latex yield per tree per tapping ($g^{-1}t^{-1}t$). Measure the volume of latex using a measuring cup. The production of each treatment is collected in the form of latex which is multiplied by the total solid content (TSC/total solid content) then divided by the number of sample plants [13].

Physiological analysis of latex was measured using TCA latex serum samples made with 1 ml of latex and 9 ml of 2.5% TCA and then analyzed for sucrose, inorganic phosphate and thiol levels. Sucrose levels were measured using the anthrone method [14]. Phosphate content is measured based on the principle of binding by ammonium molybdate reduced $FeSO_4$ in an acid reaction [15].

Thiol levels were measured from TCA serum based on the reaction principle with DTNB [16]. All latex physiological variables were analyzed using a spectrophotometer at each wavelength of 627 nm (sucrose), 750 nm (inorganic phosphate), and 412 nm (thiol).

3. Results and Discussion

The aim of latex diagnosis is to determine the impact of the treatment given, namely a combination of tapping and stimulant concentration in PB 260 clone rubber plants on the physiology and yield of latex [17]. The results showed that the S2d4 ET3.5%/15d and S4 d4 ET3.5%/15d treatments did not make a difference in latex physiology (sucrose, Pi, and Thiol) before and after application (Table 1).

Effect of the combination of tapping furrow length and stimulant concentration on sucrose content (mM) in clone PB 260

The results showed that the treatment of S2d4 ET3.5%/15d and S4 d4 ET3.5%/15d has not given any difference in latex physiology (sucrose, Pi, and Tiol) before and after application (Table 1). However, when viewed from the numbers in the treatment of S4 d4 ET 3.5%/15d higher sucrose content (13.25mM) and low Pi (22.88 mM) compared to S2 d4 ET 3.5%/15d low sucrose (10.22 mM) and high Pi (17.55 mM), this is what causes the treatment of S2 d4 ET3. 5%/15d latex production lower than S4 d4 ET 3.5%/15d (Table 1) because the treatment of S4 d4 ET 3.5%/15d has a higher sucrose content and requires relatively high Pi to convert it into latex particles [17].

The results of photosynthesis in the form of carbohydrates are broken down into sucrose in the form of disaccharides which are the basic ingredients for the formation of cis-polyisoprene located in latex vessel cells. Higher sucrose levels in the S4 d4 ET3.5%/15d treatment compared to S2 d4 ET 3.5%/15d due to several factors, namely the S2 d4 ET3. 5%/15d using renewable bark (BI-I), the bark has been used when the rubber plant begins to enter the first tapping (B0) and renewable bark is used again 5 years later after entering tapping in the upward direction, renewable bark on quick stater clones (PB 260) is generally thin so that many latex vessel networks are disconnected, less optimum for the sustainability of latex flow a little [18].

This is because the speed of bark regeneration in old plants is slower than in young plants. Renewable bark has thinned near the cambium and in old plants secondary growth occurs, namely the formation of suberin. Suberin is a waxy substance that protects the cork cells that form on the bark of trees [19]. The formation of suberin is also stimulated by the presence of openings through tapping activities. These conditions are thought to cause inhibition of the latex release process.

Treatment S4 d4 ET 3.5%/15d using virgin bark (B0) on the panel has not been used before, on virgin bark latex vessel network has not been disconnected, then the process of latex translocation and latex regeneration can take place properly, and a positive impact on the acquisition of latex and energy transfer through photosynthesis results more absorbed by the trunk of the panel that has not been used or newly used, namely virgin bark than renewable bark [20].

Table 1. Physiology of latex clone PB 260 before and after the application of a liquid stimulant exploitation system

Exploitation system	Before application			After application		
	Sucrose	Pi	Thiol	Sucrose	Pi	Thiol
	mM					
S2 d4 ET 3.5%/15d	10.22	23.51	0.25	3.97	17.55	0.29
S4 d4 ET 3.5%/15d	13.88	22.88	0.34	4.49	13.25	0.17

Note: Numbers on the same line followed by different notations are significantly different at the 5% level based on the LSD Test

S2 d4 ET 3,5%/15d: The length of the half-spiral tapping groove with the concentration of 3.5% liquid stimulant application is given once every 15 days

S4 d4 ET 3,5%/15d: The length of the quarter spiral tapping groove with the concentration of 3.5% liquid stimulant application is given once every 15 days.

Another factor of low latex production in the treatment S2 d4 ET3. 5%/15d due to the length of the tapping groove is too long resulting in the length of latex out when tapping, and latex physiology in renewable bark has begun to decrease as its sucrose has been reduced to store raw materials in the formation of latex as well as Pi as an indicator of energy change particles from sucrose into latex that has been low due to the process of plant energy that is no longer optimal distribution because of the results of photosynthate more to the trunk of rubber plants that have never been tapped such as panel H0 which has entered the top tapping or virgin bark [21].

Clone PB 260 is classified as a clone with high metabolism, so that sucrose is quickly converted into latex. This can be seen from this study that Pi levels in the S4 d4 ET 3.5%/15d treatment were lower than S2 d4 ET3.5%/15d. Pi levels are low because they have been used to support plant metabolic processes related to latex formation [22]. According to Jacob et al. [17], the ability of a clone's speed to convert sucrose into latex can be seen from the high and low levels of Pi.

The results of this study indicate that the levels of latex sucrose, in the treatment S2 d4 ET3.5%/15d and S4 d4 ET 3.5%/15d are still optimal limits (3.97-4.49 mM). According to Jacob et al. [17] the threshold of sucrose levels is 4mM-5mM [23] and minimum sucrose levels are in the range of 3.75mM.

Figure 3 shows that latex production in clone PB 260 at the age of 16 years is better with the treatment of S4 d4 ET3.5%/15d as rainfall increases. The main production of rubber plants is latex, where the formation of latex requires sufficient water supply, if rainfall is not sufficient by the rubber plant, the rubber plant has the nature of shedding leaves in each dry season as an adaptation to water shortages that will affect latex yield throughout the year [24]. This can be seen from the latex yield of PB 260 clone with the treatment of S4 d4 ET 3.5%/15d and S2 d4 ET 3.5%/15d fluctuated along the month of observation (Figure 3).

Effect of combination of tapping furrow length and stimulant concentration on organic phosphate (Pi) content (mM) in PB 260 clone

The function of Pi (inorganic P) levels is to convert the base material (sucrose) into rubber particles, Pi describes metabolic activity. If Pi levels are high and sucrose is low, this indicates high metabolic activity. Conversely, if Pi levels are low with high sucrose this clone indicates low latex metabolic activity [20].

PB 260 clone is classified as a clone with fast metabolism, which is the peak of latex yield at the age of 5-8 years, so that at the time of the study, it has experienced a decrease in latex yield characterized by latex sucrose levels below the minimum limit. This is due to the plants used in this study are already 16 years old [25]. Stimulants given to the plant clone PB 260 age 16 will increase Pi because the function of stimulants made from active etefon will be hydrolyzed in plant tissue to produce ethylene gas that activates H^+ which serves to facilitate the transportation of sucrose then stabilize lutoid and prevent blockage of latex blood vessels. Ethylene gas also serves to increase turgor pressure and latex phosphorus content (Pi) [25]. This is in accordance with the results of research Elias [25] that the combination of stimulants with S2 tapping groove length increases latex Pi levels.

This is in accordance with the results of research Elias [25] that the combination of stimulants with tapping furrow length S2 increases the level of latex Pi. In this study that Pi levels in the treatment S4 d4 ET 3.5%/15d are lower than in the treatment S2 d4 ET3.5%/15d. Low levels of Pi because it is used to support the metabolic processes of plants related to the formation of latex can be seen in Table 2, higher latex production in the treatment of S4 d4 ET 3.5%/15d. The speed of a clone's ability to convert sucrose into latex can be seen from the high and low levels of Pi. Pi levels (13-17.55mM) in PB 260 clones after being treated are still in the optimal range. According to Jacob et al. [17] the range of optimal Pi levels is 10-30mM. According to Suherman [24], indications of plants experiencing metabolic excess indicate that the plant is attacked by disease with Pi levels> 30mM.

Effect of the combination of tapping groove length and stimulant concentration on Thiol levels (mM) in PB 260 clones

Measurement of latex diagnosis (sucrose, Pi) is more perfect, when combined with the analysis of thiol levels, because thiol levels in latex vessels are an indication of the ability to handle aging mechanisms in plants [17]. The function of thiol levels in latex vessels is very useful for plants because it activates enzymes to maintain the balance of lutoid in the cytoplasm so that latex continues to flow [2].

The results of the treatment given have not affected thiol levels, judging from the numbers before being treated, thiol levels in the S4 d4 ET3.5%/15d treatment are higher (0.34 mM) than after being treated (0. 17 mM). This is because the stimulant given can reduce the activity of the oDPO oxidase enzyme [25] seen from the numbers. There is a difference in thiol levels between the S2 d4 ET 3.5%/15d and S4 d4 ET3.5%/15d treatments, but still in a safe stage under the threshold of low stress values (thiol levels 0.17-0.29 mM). According to Jacob et al. [17] the optimal thiol level is 0.2-0.9mM.

Effect of Combination of Tapping Furrow Length and Stimulant Concentration on Latex Yield ($g^{-1}t^{-1}t$) on PB 260 clone

The results showed that the treatment of S2 d4 ET3.5%/15d and S4 d4 ET3.5%/15d in January, April, June, and July affected latex production while in February and March had not affected latex production in PB 260 clone. This is due to the month of February and March experiencing the peak phase of leaf fall in rubber plants so that the results of photosynthesis are few, the leaves are a place to carry out photosynthesis, if the leaves have been reduced so that very little to produce photosynthate and low latex yields. The results of research Febbiyanti, and Fairuzah [26] and Damiri et al. [27] reported the result of leaf fall on rubber plants can reduce latex yields by 25-45%.

This study indicates that the length of the S4 tapping groove giveshigher latex yield than the length of the S2 tapping groove with a combination of liquid stimulants. In line with the results of research, Junaidi [28] showed that the results of tapping old plants S4 virgin bark are higher than tapping S2 renewable bark on rubber plant clone PB 260. Related to this, Perp étue et al. [29] state that renewable and virgin barks have different physiological levels of latex and also depend on the number of leaves on the rubber plant in old age.

In February and March latex yields decreased, high latex yields began in April-July. This is because in January and February the state of the leaves of the plant is still full but has not experienced leaf fall which is also followed by low rainfall. Hazir et al. [30] state that the main factors affecting plant growth and high and low latex yield are rainfall and minimum temperature in an area.

In March the latex yield was slightly higher than that in January and February. This is because in March, the leaves of the rubber plant began to grow back after leaves fall so that the photosynthesis process began to slowly improve or began to optimize so that the latex yield increased slightly more than January and February.

According to Tistama et al. [31], when the water in the soil is little, rubber plant will shed leaves naturally as a reaction to the lack of water that occurs in the dry months of each year, the rubber plant will be more inclined to shed its leaves to survive the environment that lacks water, then the latex yield is reduced, because the leaves serve as a place of process asymylate source (source). This is related to the process of photosynthesis that requires enough water to produce sucrose as a latex forming material. Furthermore Priyadarshan et al. [32] state that low rainfall is one of the causes of rubber plants that shed their leaves resulting in a decrease in latex flow rate.

Latex production in April has increased and is different compared to the latex yield in March, because in April the beginning of the application of liquid stimulants and the condition of the leaves of plants that have started a lot and sufficient soil water conditions (132 mm/month) compared to March (34mm / month). Hazir et al. [30] said that optimal rainfall for optimal latex yield is between 2000-2500 mm/year with an average temperature of 26-28 ℃.

In May, June and July, leaf conditions are full and supported by rainfall that continues to increase, in April (132mm / month), May (258mm / month), June (370mm / month) and July (378 mm/month), this is what causes the process of photosynthesis plants to run optimally so that latex production is also higher. According to Sugebo et al. [34], the increase in latex production is influenced by the condition of soil water and leaves as a place of sufficient assimilate so that the rate of photosynthesis runs optimally, the impact on the yield of maximum assimilate and subsequently increased latex yield.

Table 2. Results of latex clone PB 260 with the exploitation system from January to July

Exploitation system	January	February	March	April	May	June	July
	Yield latex $kg^{-1}t^{-1}t$						
S2 d4 ET 3.5%/15d	0.46b	2.85	3.75	7.56b	27.77	13.15b	30.01b
S4 d4 ET 3.5%/15d	0.57a	3.31	4.57	13.15a	22.03	22.39a	50.09a

Note: Numbers on the same line followed by different notations are significantly different at the 5% level based on the LSD Test

S2 d4 ET 3,5%/15d: The length of the half-spiral tapping groove with the concentration of 3.5% liquid stimulant application is given once every 15 days

S4 d4 ET 3,5%/15d: The length of the quarter spiral tapping groove with the concentration of 3.5% liquid stimulant application is given once every 15 days.

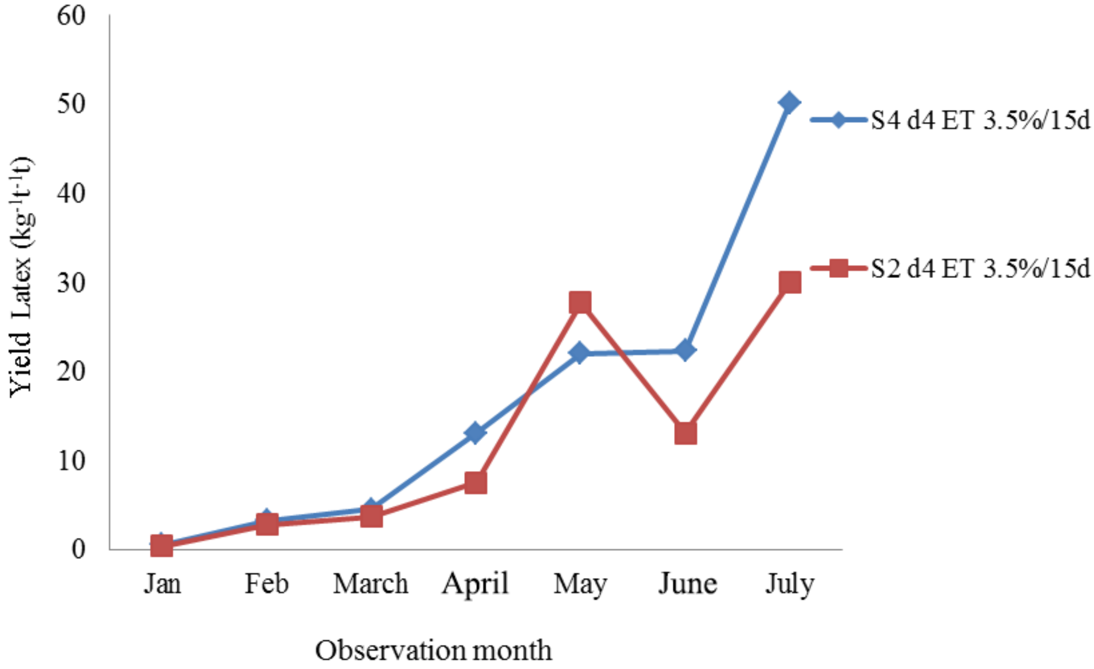

Figure 3. Results of PB 260 Clone Latex using the exploitation system in January-July

Figure 3 shows that latex yields are better with the treatment of S4 d4 ET3.5%/15d on PB 260 clones at the age of 16 years. The main production of rubber plants is latex, where the formation of latex requires sufficient water supply, if rainfall is not sufficient by rubber plants, then rubber plants have the nature of shedding leaves in each dry season as an adaptation to water shortages that will affect latex yields throughout the year [32]. This can be seen from the latex yield of PB 260 clone with the treatment of S4 d4 ET 3.5%/15d and S2 d4 ET 3.5%/15d fluctuated along the month of observation (Figure 3).

4. Conclusions

Latex production increases with increasing rainfall and leaf development from fall to full leaf.

The results showed that the treatment of S4 d4 ET 3.5%/15d and S2 d4 ET 3.5%/15d has not affected the physiology of latex (sucrose, Pi, and thiol) in PB 260 clones aged 16 years, judging from the use of bark tapping field treatment S4 d4 ET 3.5%/15d which is relatively more efficient to use on PB 260 clones for plant age 16 years. It is seen from the use of bark using tapping furrow length ¼ (one fourth) and latex physiology levels are quite safe for plants and high latex yield (50.09 $t^{-1}t^{-1}$).

This treatment is still within the reasonable threshold. It is seen from the thiol levels which are still in the lower threshold (0.17-0.29mM).

The results of this study can be taken for better decisions in the application of the tapping system applied in smallholder rubber plantations.

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