INCREASED THE PRODUCTIVITY OF PB 260 CLONE RUBBER PLANTS THROUGH STIMULANT CONCENTRATION AND TAPPING INTERVAL IN AFTERNOON TAPPING TIME

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ABSTRACT

Quick starter clones dominate rubber plantations in Indonesia. One of the problems of these clones is often dry tapping grooves on the bottom due to incomplete and intensive tapping, resulting in low productivity and a poorly recovered peel (thin and uneven). The low yield and quality of latex on smallholder plantations are affected by high tapping frequency on the same tree so that the virgin bark is used up quickly, and the quality of the recovered bark is low. Therefore, the research aimed to increase the latex yield of 12-year-old PB 260 clone rubber plants using different liquid stimulant concentrations and tapping intervals. The research was conducted in Naga Rejo Village, Deli Serdang Regency, North Sumatra Province, Indonesia. The research method used a factorial randomized block design with two factors: stimulant concentration treatment (0, 2.5, 3.5%) and tapping interval (3, 4, 5 days once tapped) repeated three times. The results showed that applying a stimulant concentration of 2.5% and tapping intervals every four days can increase latex yields and optimum latex physiological conditions.

Keywords: latex physiology; PB260; stimulant concentration; tapping interval.

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INTRODUCTION

The yields of natural rubber in Indonesia are still low and far behind Thailand, which is in first place (International Rubber Study Group, 2013). According to the Ministry of Agriculture of Indonesia (2022), the latex yield in Indonesia in 2022 was only 3.13 million tonnes/ha. In addition to low productivity, other problems now include latex quality and low selling prices due to high-intensity tapping carried out daily on the same tree. It quickly depleted the basal of virgin bark, and the renewed bark is low-quality (Aikal, 2016). This requires research to overcome this problem and increase the yield and quality of latex.

Another problem is farmers' habit of tapping. The Deli Serdang farmer usually taps in the afternoon (2.00-3.00 pm). In contrast, tapping time in the morning (05.00-06.00 am) with high turgor pressure conditions in the latex vessels caused the latex discharge to flow profusely (Ayele et al., 2001). Furthermore, Jacob et al. (1989) revealed that the best time to do tapping is when the turgor pressure is still high, namely at 05:45 am, according to the time of each region. Jacob & Prevot (2018) showed that tapping in the morning secretes more latex than other tapping times because the turgor pressure is at its highest point, 10-14 atm.

Tapping too intensively will majorly affect the low carbohydrate content in the stem. On the other hand, rubber trees that are not tapped have higher carbohydrates (Jacob et al., 1989). Carbohydrates as a substrate are needed for the regeneration and biosynthesis of latex as a source of metabolic energy, considering that tapping is an additional sink diverted or deflected towards carbohydrates from its primary function (Silpi et al., 2007).

For the planning of latex yields and future yield periods with high productivity and long economic life, it is necessary to look at the tapping technique. Setting the exploitation system can be done by paying attention to bark consumption, tapping skills in tapping, and the use of stimulants (Robianto, 2013).

Tapping frequency is the tapping time interval in units of time in days (d), weeks (w), months (m), and years (y). This unit depends on the tapping system. If tapping is carried out continuously daily, then the tapping is marked with d/1. Meanwhile, if done two days apart, the time is marked with d/2, and so on.

The stimulant application aims to extend the flow of latex (Siregar, 2001). The stimulation is generally recommended and applied to mature rubber trees when they reach 15 (Lacote et al., 2010). Furthermore, Herlinawati & Kuswanhadi (2013) stated that the use of stimulants must be accompanied by a decrease in frequency from once every two days (d2) to once every three days (d3) or every four days (d4) so that plant physiology is healthy, besides that, the basic costs are low, especially tapping costs.

The stimulant's concentration and frequency of tapping determine the efficiency of using stimulants in rubber plants so we can know the elicited response. It is necessary to know the concentration of stimulants and the optimum tapping frequency to produce high-yield and quality latex. This is to maintain the continuity of stable latex yields and increase yields during peak periods. Based on the problems above, the research objective is to increase latex production with stimulant concentrations (0% tapped 15d (control), 2.5% 15d, and 3.5% 15d) and tapping intervals (tapped once every three days (d3), once every four days (d4), and once every five days (d5). This research used a PB 260 clone aged 12 years.

MATERIALS AND METHODS

The research area was chosen in Deli Serdang, North Sumatera, Indonesia, as the second most extensive smallholder rubber plantation after South Sumatera. This research was carried out in a smallholder rubber plantation in Naga Rejo Village, Deli Serdang Regency, North Sumatra Province, with an altitude of 25 meters above sea level and flat topography. The research plot area coordinates are 3028'07"N 98052'50"E.

Materials

The study used a 12-year-old PB 260 clone planted at 6 m x 3 m spacing. Trees with a circumference of 60-70 cm (measured at a height of 130 cm from the grafting intersection), good leaf condition (no leaf fall), and healthy (no tapping panel dryness (TPD)) were selected as samples. Stimulants in this research used Ethephon.

Methods

The research method used a factorial randomized block design with two treatment factors: stimulant concentration (0, 2.5, 3.5%) and tapping intervals (3, 4, 5 days once tapped) repeated three times. The Analysis of Variance (ANOVA) was performed for all parameters, followed by Duncan's Multiple Range Tests (DMRT) at $\alpha = 0.05$

Tapping Intervals and Application of Stimulant

The time and interval of tapping are adjusted according to the treatment. The tapping is carried out in the afternoon (3.00 pm) and is tapped once every three days (d3), once in four days (d4), and once in five days (d5). The application of stimulants was carried out in April.

Observational Variables

1. Latex yield (g.tree^{-1})

Rubber production is measured based on latex and lump production per tree, which is converted to dry production in grams per tree (g.tree^{-1}) per tap after being multiplied by the value of dry rubber content (DRC).

2. Sucrose (mM)

For physiological analysis of latex, samples were taken according to the treatment of 5 trees for each treatment immediately one hour after tapping. Observations were made in June when the canopy was full. Latex samples were taken as much as 150 µL and added 2.5% TCA until the total volume reached 500 µL— the anthrone method measured sucrose content (Diche, 1962). Dehydration of sucrose in concentrated sulfuric acid (70% H2SO4) and heating produced a furfural derivative, which reacted with anthrone to produce a blue reaction, which was then measured for its absorbance of wavelength 627 nm with a Beckman DU 650 spectrophotometer (Beckman et al., California -USA).

3. Inorganic Phosphorus (mM)

Inorganic Phosphorus (Pi) content was measured based on the principle of binding with ammonium molybdate and then reduced with Nitric acid in an acid reaction to a blue color, which was then measured for its absorbance of wavelength 410 nm (Taussky & Shorr, 1953).

4. Thiol (mM)

The concentration of thiols is based on the principle of reaction with dithiobis-nitrobenzoic acid (DTNB) to form yellow TNB, which is absorbed of wavelength is "412 nm (McMullen, 1960).

5. Latex pH

The pH of fresh latex was determined using a pH meter. First, we take a latex receiving cup containing fresh latex and then put litmus paper. The litmus paper calculates the latex's pH, whether it is acidic, neutral, or alkaline.

6. Plugging Index (PI)

Plugging Index (PI) was observed based on the calculated method of Milford et al. (1969). The latex volume for the first five minutes was calculated, divided by the total latex volume, and multiplied by 100. Observations of PI were made by following the tapping at the beginning of exploitation (± 05.30 am). Measuring the initial (for 5 minutes) and final (total) volumes of latex with a measuring cup in each experimental unit, the equation for measuring the plugging index (PI) is as follows:

PI=[(Latex volume in 5 min)/5 x 100]/total volume

RESULTS AND DISCUSSION

Results

Treatment of stimulant concentrations affected the physiological characteristics of rubber clone PB 260 aged 12 years in farmer's plantations, namely sucrose and Pi content. The treatments did not affect thiol levels, pH, and Plugging Index (PI) (Table 1).

Without stimulant treatment (0%), the sucrose content was higher (16.29 mM). In comparison, 2.5% and 3.5 % stimulant concentrations gave lower sucrose (10.08 mM and 5.20 mM, respectively), approaching the lower limit of the sucrose content range. Sumarmadji & Tistama (2004) stated that it was classified as high if the sucrose content was >8 mM and low if <5 mM. In addition, the 2.5% treatment showed the highest Pi (18.05 mM) and was different from 0% (14.21 mM) and 3.5% (12.23 mM).

The tapping interval treatment affected the physiological characteristics of rubber clone PB 260, namely Pi. However, it did not affect the levels of sucrose, thiol, pH, and IP, but there was a slight increase in sucrose content, which was in line with Pi. The longer the tapping interval, namely treatment one tap in four days (d4) and treatment (one tap in five days (d5), the sucrose content was higher compared to the treatment (tapped once every three days).

Table 1. Physiological characters of PB 260 latex clone with stimulant concentration treatment and tapping interval

Exploitation system	Latex Physiology				
	Sucrose	Pi	Thiol	pH	PI
	.....mM.....				
Liquid Stimulant Concentration					
0%	16.29a	14.21b	0.30	6.62	25.64
2,5%	10.08b	18.05a	0.33	6.60	25.45
3,5%	5.20c	12.13c	0.32	6,62	25.58
Tapping Intervals					
once every three days (d3)	10.33	14.11c	0.32	6.62	25.46
once every four days (d4)	10.64	15.53a	0.32	6.60	25.61
once every five days (d5)	10.66	14.76b	0.31	6,62	25.60
Combination					
Tapping interval d3 without stimulant (control)	15.60 b	13.77 d	0.30	6.62	25.54
Tapping interval d3 and 2.5% stimulant concentration	10.65 c	16.20 c	0.34	6.63	25.40
Interval tapping d3 and 3.5% stimulant concentration	4.56 d	12.35 e	0.33	6.63	25.45
Tapping interval d4 without stimulant (control)	16.64 a	14.22 d	0.30	6.60	25.73
Tapping interval d4 and 2.5% stimulant concentration	9.75 c	20.32 a	0.34	6.60	25.45
Interval tapping d4 and 3.5% stimulant concentration	5.54 d	12.04 e	0.32	6.60	25.65
Tapping interval d5 without stimulant (control)	16.65 a	14.64 d	0.30	6.62	25.65
Tapping interval d5 and 2.5% stimulant concentration	9.83 c	17.65 b	0.32	6.63	25.51
Interval tapping d5 and 3.5% stimulant concentration	5.50 d	12.00 e	0.32	6.62	25. 64

Note: Numbers in the same column followed by different notations show significant differences at the 5% level based on the Duncan test

The combination of stimulant concentration and tapping interval treatments in the 3, 4, and 5-day tapping interval treatment with a 2.5% stimulant concentration showed decreased sucrose content. However, there was no difference between the treatments, while the highest Pi content was different in the 4-day tapping interval treatment and a 2.5% stimulant concentration. With 3 and 5 days and 2.5% stimulant concentration.

Treatment of stimulant concentrations and tapping intervals did not affect latex yields from January to March. There were differences in April, May, and June, but did not affect again in July (Table 2).

Discussion

Increasing the stimulation concentration to 2.5% affects the physiological character by disrupting the sucrose content until it approaches the lower limit for its availability and the Pi/energy required for metabolic processes, which also approaches the lower limit. This opinion is in line with Tistama & Siregar (2005), which stated that the concentration of Pi tends to continue to increase as the concentration of ethephon increases. This incident indicates that ethephon can increase metabolic activity in latex vessel cells.

Generally, increasing Pi levels will be followed by decreasing sucrose in latex vessels. The raw material for the formation of rubber particles is sucrose. The high sucrose indicator indicates a good influx in latex vessel cells. Giving stimulants tends to reduce the sucrose content in cells.

Table 2. Latex yield of clone PB 260 treated with stimulant concentrations and tapping interval with tapping time in the afternoon (15.00 WIB)

Exploitation system	Observation Month						
	Jan	Feb	March	April	May	June	July
	..... Latex yield (g.tree^{-1}).....						
Liquid Stimulant Concentration							
0%	1.18	0.94	1.02	1.16b	1.20b	1.23	1.26
2.5%	1.18	0.95	1.08	2.11a	2.32a	1.36	1.23
3.5%	1.16	0.94	1.03	2.35a	2.40a	1.29	1.18
Tapping Intervals							
once every three days (d3)	1.14b	0.92b	0.95b	1.92	2.01	1.27	1.21
once every four days (d4)	1.17ab	0.95a	1.07a	1.92	1.91	1.30	1.22
once every five days (d5)	1.21a	0.96a	1.11a	1.78	2.00	1.31	1.23
Combination Exploitation							
Tapping interval d3 without stimulant (control)	1.13	0.91	0.88	1.17	1.20	1.27	1.25
Tapping interval d3 and 2.5% stimulant concentration	1.15	0.92	0.98	2.13	2.30	1.32	1.22
Interval tapping d3 and 3.5% stimulant concentration	1.13	0.92	0.98	2.47	2.53	1.23	1.17
Tapping interval d4 without stimulant (control)	1.18	0.94	1.05	1.25	1.23	1.20	1.27
Tapping interval d4 and 2.5% stimulant concentration	1.15	0.95	1.15	2.23	2.22	1.37	1.23
Interval tapping d4 and 3.5% stimulant concentration	1.17	0.97	1.00	2.28	2.28	1.32	1.17
Tapping interval d5 without stimulant (control)	1.22	0.96	1.12	1.05	1.18	1.22	1.27
Tapping interval d5 and 2.5% stimulant concentration	1.23	0.97	1.10	1.98	2.43	1.38	1.23
Interval tapping d5 and 3.5% stimulant concentration	1.18	0.94	1.10	2.30	2.38	1.33	1.20

Note: Numbers in the same column followed by different notations show significant differences at the 5% level based on the Duncan test.

As a result, the more active rubber biosynthesis requires more sucrose to be converted into rubber particles so that the sucrose content is low; low Pi levels do not support the course of latex biosynthesis, resulting in slow latex formation due to low energy supply, while high Pi indicates active latex metabolism causing particle biosynthesis. This aligns with Sumarmaji & Tistama (2004), stating that Pi levels describe energy availability in latex vessel cells to convert sucrose into latex particles.

Giving ethephon can increase the pH in latex, although several studies suggest that the increase in pH due to the application of ethephon is not significant (Fernando et al., 2019). Changes strongly influence higher or lower enzyme activity in pH. Increased activity of these enzymes causes increased rubber biosynthesis (Tistama, 2013). In addition to latex pH, thiols activate several enzymes, especially those related to environmental stress (Nair et al., 2004). The optimal thiol content ranges from 0.4-0.9 mM (Sumarmadji & Tistama, 2004).

Gunaseraka et al. (2007) suggested administering the stimulant ethephon (2.5%) in several rubber plant genotypes reduced PI. The Plugging Index is closely related to production because it reflects the flow time of the latex. If the PI is high, it means that latex flows slowly. This is in line with the research results of Tistama (2009), which stated that excessive ethephon also results in the cessation of latex flow caused by the coagulation of rubber particles known as TPD.

The influence of the tapping interval on Pi can be explained by the fact that PB 260 is a

quick starter clone with a high/fast metabolism in latex regeneration. Besides that, the condition of the plants during the study was attacked by a physiological disease, namely tapping panel dryness (TPD), which greatly affected the physiological characteristics of the plants.

The tapping interval treatment did not affect thiol levels, and the value was below the optimal limit because the plants were attacked by tapping panel dryness (TPD). Then, the pH value is strongly influenced by genetic factors, while the high PI is caused by the tapping time, which is done during the day, and the condition of the plants that TPD attacks.

The statement above is in line with the research results of Tistama (2013) that latex formation occurs for 48 hours; if the tapping treatment is too fast, then the amount of latex produced is minimal because the maturity level of the latex formed could be better. It takes a minimum of 48 hours to wiretap again. Evrizal (2015) states that latex biosynthesis takes about 42 hours (2 days); if trees are tapped daily, cell regeneration to produce new latex will be challenging. Therefore, increasing the production of dry rubber reduces tapping intensity. Resting the plants for a specific time is also a concept of tapping field recovery because the plants will re-optimize the parts of the plant that have been injured.

The treatment of tapping intervals of 3, 4, and 5 days with a stimulant concentration of 3.5% showed a decrease in physiological characteristics because the plant could not withstand high concentrations of stimulants (3.5%) even though the skin was rested for a long time. This is in line with the opinion of Das et al. (2002), who stated that abnormal tapping, such as the frequency of tapping or overdosage of stimulant use, may be the cause of physiological problems. The conclusion from the research of Wulan et al. (2019) is that a combination of low-frequency tapping systems and stimulants can be applied when rubber prices tend to be low and in areas where tapping power is scarce.

When viewed from the physiological characteristics of latex, such as sucrose and Pi content, they are optimal for processing latex biosynthesis. However, the thiol content ranges from 0.30-0.33 mM, which indicates the plant is unhealthy or attacked by TPD, so sucrose, which has turned into latex particles, cannot be released optimally due to dry latex vessels. As a result, the yields obtained could be higher. In addition, the conditions during the research were a dry season, and the plants lacked water.

This can be explained by the fact that the application of stimulants was carried out in April, so there was no significant difference from January to June because the plants had not been given stimulants; there was an increase in yields in April-May because the plants had been given stimulants and there was a visible effect due to the treatment given stimulants at concentrations of 2.5% and 3.5%, while yields decreased in June-July due to attacked by TPD.

Aikal (2016) stated that the use of stimulants can increase the yield of latex. However, it must be considered by looking at the condition of the plant's ability because of the high concentration of stimulants, the plants lose much water, which causes the plants to become stressed, resulting in tapping panel dryness (TPD) and stem rot disease due to high intensity of tapping.

Wulandari et al. (2015) stated that several regulations in applying stimulants must consider the dosage/concentration and proper application techniques. Furthermore, Aji et al. (2021) stated that the cause of TPD was tapping with high intensity (over-exploitation) or giving stimulants that were not according to the rules.

Over the age of trees, they are often reported to experience higher TPD due to interactions with higher levels of exploitation. Aziz et al. (2021) stated that a high sucrose content in rubber plants would not necessarily have a high latex yield because a high sucrose content has not been directly correlated. Instead, it can describe low production because a certain amount of sucrose may not be synthesized into latex.

Over the age of trees, they are often reported to experience higher TPD due to interactions with higher levels of exploitation. Aziz et al. (2021) stated that in rubber plants, a high sucrose content will not necessarily have a high latex yield because a high sucrose content has yet to have a direct meaning as an illustration of its production potential. Instead, it can describe low production because a certain amount of sucrose may not be synthesized into latex. However, there is a critical limit to the amount of sucrose available to latex vessel cells for latex synthesis.

CONCLUSION

From the results of the study, it was found that giving stimulant concentrations (0, 2.5, 3.5%) in afternoon tapping time gave differences in the physiological characteristics of latex. The best stimulant concentration was 2.5%. Tapping intervals did not show any

difference in the physiological characteristics of latex in rubber clone PB 260 aged 12 years. Applying a tapping interval of 4 days (d4) and a stimulant concentration of 2.5% showed the best physiological characteristics. There was no difference with the treatment of tapping interval every five days (d5) with a stimulant concentration of 2.5%.

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