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THE EFFECT OF HIGH STIMULANT CONCENTRATIONON THE YIELD AND DRY RUBBER CONTENT OF HIGH METABOLIC CLONE RRIM 911 IN LOW-TAPPING FREQUENCY PRACTICE

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Abstract

The low-frequency tapping (d4) offers an opportunity to exploit the latex through the increments of stimulant concentration and application frequency. This study compared the yield and dry rubber content (DRC) from three different stimulant compounds i.e. etephon 5.0% (ET), polyethylene glycol 3.0% + palmitic acid 0.2% + etephon 5.0% (EN), and polyethylene glycol 3.0% + palmitic acid 0.2% (NS). A field trial was carried out at Tanah Besih Estate, North Sumatera using 17 years of age RRIM 911 clone based on Complete Block Design. The data was collected from May 2017 to February 2018. The result suggested that the ET was the strongest compound that able to generate higher yield (56.37 $gt^{-1}t^{-1}$) than EN and NS (56.37 $gt^{-1}t^{-1}$ and 34.00 $gt^{-1}t^{-1}$ respectively). Nevertheless, the high concentration tended to have a slightly lower DRC. When etephon was combined with other compounds, it lowered the effect on the yield. All treatments showed that the first and second tapping after stimulant application generated highest yield. The yield in mature leaves had lowed yield in ET and EN treatments, while NS showed a significant increase. Our result suggested that the application of high concentration of etephon was very effective to obtain the yield.

***Keywords**: Dry rubber content, Hevea brasiliensis, latex stimulant, low-tapping frequency, yield*

INTRODUCTION

Tapping is the biggest cost component in the exploitation of rubber plants, reaching 40-50% of the total production costs. The high production costs will affect the overall competitiveness of rubber plantations. Low rubber prices over the past 5 years and an exponential increase in labor wages have caused rubber agribusiness companies to reduce costs. Rubber agribusiness can survive if it takes two approaches: optimizing production and suppressing tapping costs (Sumarmadji, et.al, 2017). In a context of expensiveness or scarcity of tapping labor, the tendency is to reduce the tapping frequency (Soumahin, 2009; Vijayakumar et al., 2003, Rajagopal et al., 2003) because it helps to solve the problem of availability of tappers.Implementing low intensity tapping systems increase the tapper productivity and lesser tapping amount which is important consideration of rubber farmers under current situation of low rubber prices and high labor wages (Vijayakumar, et.al, 2001; Vijayakumar, 2008). LFT system showed a markedly decrease of bark consumption comparing with the traditional tapping system (d2 or d3) (Sainoi et.al, 2016). Less consumption lead to increase life span of rubber trees because it may increase replanting cycle up from 30 years to 36 years (Nugawela et al., 2000; Rodrigo, 2007). Besides, the commencement of tapping in renewed bark could be delayed, this may increase the additional time for bark regeneration (Rodrigo et al, 2011). Reductions in the intensity of tapping have the advantage of generating a better rubber yield while favouring a good vegetative growth and a low rate of tapping panel dryness (Soumahin et al., 2009). However the implementing make decline yield especially in the annual cumulative yield.

Therefore, the implementation of low intensity tappingsystems implies, compared to standard tapping systems,a reduction in the intensity of tapping (reduction of tappingfrequency and/or tapping cut length). This reduction intapping intensity must be at least partially compensatedby an increase in the intensity of hormonal stimulation(Vijayakumar et al., 2001; Soumahin,2003; Soumahin et al., 2009; Obouayeba et al., 2006).The research of stimulant and tapping has been done since 1951 in order to increase latex yield by prolonging the period of latex flow. Various chemical compounds have been observed, namely defolatan, phosponium, growth regulator, and ethylene release compound as stated by Tistama and Siregar (2005). In the other research conducted by Felicia et.al (1989), there is possibility to produce ethylene from leave of Gliricida, Samaneasaman, Leuccephala, or averrhoacarambola. Also. The use of garlic extract on papaya show prolonged period of papain latex due to its antibiotic and anticoagulant contents (selenium and methyl allyltrisulfida).Abraham et.al (1971) complies various chemical compound that can prolog latex

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flowing period and as defolatan (Ferric chloride, chlorox, 2-butyene1-4 diol, chloro acetic acid, pottasium iodide and cinamic acid). It is reported that chloro acetic acid, pottasium iodide, B-hydroxyethyldrazin shows a good response. Also Phosphonium compounds 2-hydrozy ethyl, tri-phenyl phosphoniumchoride (ethyl)-tri-phenyl phosphoniumbromiideand (m-propyl)-tri phenyl phosponium bromide indicate similar response.

Up to now, the stimulant has been ordinarily used is ethephone (2 Chloroethanephospinic acid)and some use polyethilenglycol (PEG) base. Despite yield is increase, this stimulant has caused TPD and in the long run it gives great loss. Though containing ethepone, the new stimulant. Should be well formulated to avoid negative effects as well as to increase more yield when compared with the farmer stimulant namely is ethepone without formulation addition.In commercial scale, ethephone is the best stimulant compound to prolog latex flow. The use has been commercially implemented since early 1970"s. Then the problem occurs due to use ethephone, namely tapping panel drynes (TPD) (Krishnakumar et.al, 2003). This phenomenon has shortened the economic life of the plant new formulation with ethephone as the main material is badly needed to minimize TPD risk, accelerate bank renewal and obtain more productivity compared with the use of ethephoneit self.PEG-based stimulants by combining oleo chemical in high metabolism clones have been studied by Rahayu et.al (2015). They use PEG and oleochemicals is intended to reduce the negative effects of stimulant use and higher yield. The result showed that PEG and palmitate acid as oleochemicals have the potential to increase yields in conventional tapping (d3). In the current condition, the application of LFT is effective if yield remains high, it is expected that this can be achieved if it combines high-dose stimulants. This research is expected to get a combination high concentrationof ethephone with PEG and oleochemicals that can give high yields on low intensity tapping system.

MATERIAL AND METHOD

The research was carried out in the Tanah Besih Estate, PT. Socfindo, Tebing Tinggi, North Sumatra (3,325141, 99,210727) starting in May 2017 - February 2018. The first stimulant application is carried out when the leaves return to normal with moderate rainfall conditions. Rainfall during the experiment was wet (4 months) with rainfall> 200 mm, 4 months with intermediate rainfall of 100-200 mm, and dry (2 months) with rainfall <100 mm. The experiment was carried out at the RRIM 911 clone (high metabolism) aged 17 years (planting year 2001) withupward tapping system (S/4) on the HO-1 panel.

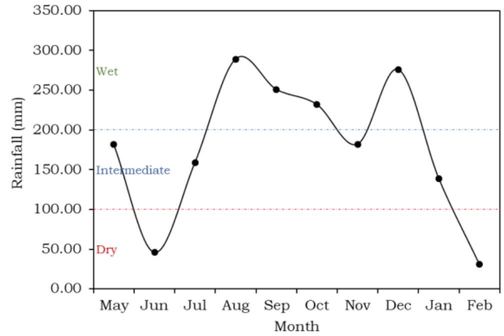

Figure 1. Monthly rainfall in Tanah Besih Estate during the research

This study uses a randomized complete block design with three stimulant treatments. Each treatment is carried out 3 repetitions so that there are 9 experimental units. Each experimental unit consists of 100 sample plants. The sample tree used has healthy plants with same diameter and position of the tapping panel. The treatment given is:

1. ET : Ethephone 5%
2. EN : polyethylene glycol 3.0% + palmitic acid 0.2% + ethephone 5.0%
3. NS : polyethylene glycol 3.0% + palmitic acid 0.2%

Rubber yield is the main thing in rubber plants, while the dry latex rubber content can be used as an early indication of changes in latex metabolism caused by stimulant. Because of this, these two parameters are very important to study more deeply.

a) Yield (g / t / t)
Yield parameters are observed for every tapping (once every 4 days). Firstly, yield measurement by weighing the wet weight of the latex and cup lump on 100 sample trees. Yield per tree is obtained by multiplying wet weight and DRC of latex or lump.

b) Dry rubber content / DRC (%)
Measurement of latex DRC using Metrolax equipment on each tapping (once every 4 days), while DRC lump was observed with a ratio of wet weight and dry weight obtained by natural drying. Metrolax is a DRC measurement tool that uses a gravimetric method or based on specific gravity. The DRC value can be known by reading the value on a scale then multiplied by the correction factor. This method of measuring is done by mixing latex and water in a ratio of 1: 2.

Data analysis was performed with statistical software R version 3.4.2 (R Development Core Team) and R Studio (version

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1.1.383). The analysis method uses a one-way Analysis of Variance (ANOVA) with least square means comparation using the Tukey method at $\alpha = 0.05$.

RESULT AND DISCUSSION

The Effect on the yield and Dry Rubber Content

The monthly yield and DRC exhibited a fluctuation pattern. The ET and EN treatments showed a high yield in May to July then relatively constant from August to February. Whilst NS treatment showed a constant yield from beginning of the study until the end (Figure 2). The NS had a slightly higher DRC than the others, while ET and EN had relatively same DRC. All treatments showed a similar month-to-month pattern of the DRC.

Yield of latex in August and December was decline due to high rainfall with rainfall intensity exceeding 250 mm. High rainfall is a constraint in tapping because it can reduce effective tapping days per month or loss of results due to rain. Different things are seen in the high DRC values during high rainfall conditions. This is possible because the high rainfall becomes the trigger for latex to quickly swell in the tapping groove so that the duration of the latex flow is shorter. Shorter latex flow directly affects the high DRC value obtained. The longer the flow of latex that occurs is negatively correlated with DRC because the more cytosols in the latex vascular tissue are released. Chantuma (2016) rain affects the decrease in tapping days and increases in disease attacks so that it can reduce production by around 14 - 41%.

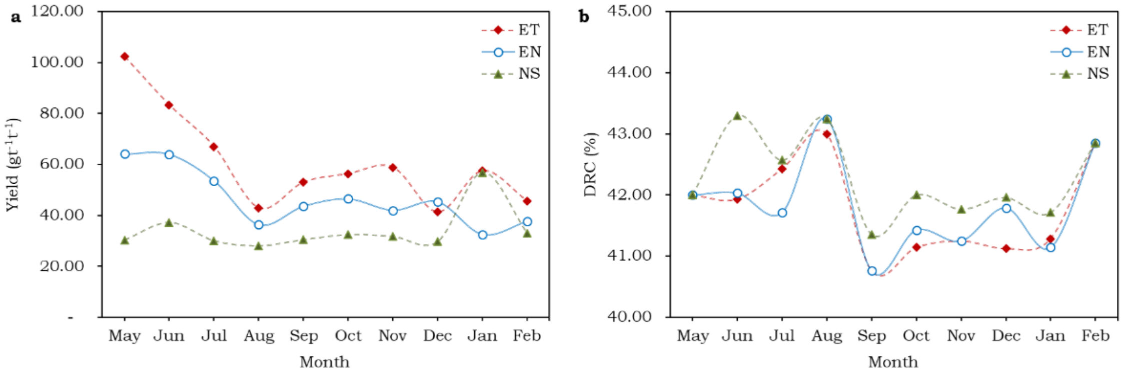

Figure 2. Monthly yield (a) and DRC (b) each treatment during the research

As predicted before, the stimulant compound influenced significantly on the yield ($p < 0.0001$) but not the DRC ($p = 0.3104$). The etephon 5.0% solely applied (ET treatment) had significantly higher yield (56.37 $gt^{-1}t^{-1}$) than other treatments.The EN treatment had an average yield 56.37 $gt^{-1}t^{-1}$, lower than ET but higher than NS which obtained yield 34.00 $gt^{-1}t^{-1}$ (Figure 3). Inversely, the DRC data showed that NS had higher DRC than others although it was not statistically significant. It was an important proxy for the physiological fatigue experienced by the plants due to stimulant application.

Ethepone decomposes in plant tissues to release ethylene which delays the plugging process and increase latex flow time resulting in higher yields (Jetro, 2006). The delayed plugging could be due to an increase in lutoid stability (Jacob, et. Al., 1988). Ethylene increase the duration of latex flow after tapping and activities the latex cell metabolism (Buttery and Boatman, 1967; Lustinec et al., 1965; Pakianathan et al., 1976; Jacob et al., 1989; d'Auzac et al., 1997). Rajagopal et al. (2004) who used Ethrel. 2-chloroethylphosphonic acid decomposes with the help of the physiological medium when pH is higher than 3.5 and releases ethylene which is a phytochrome that facilitates hydrous transfer within the tissue of H. brasiliensis and thus latex flow. The volume of latex produced is increased as well as latex regeneration between tappings, enhance latex flow and is duration after tapping (Coupé and Chrestin, 1989). DRC has a positive correlation with tapping intensity (tapping interval or stimulant). The three stimulants do not give significantly to DRC, this means the level of tapping intensity of the three treatments is almost the same. However, NS treatment has a higher value than other treatments, it is possible that pressure on plants is much lower than other treatments.

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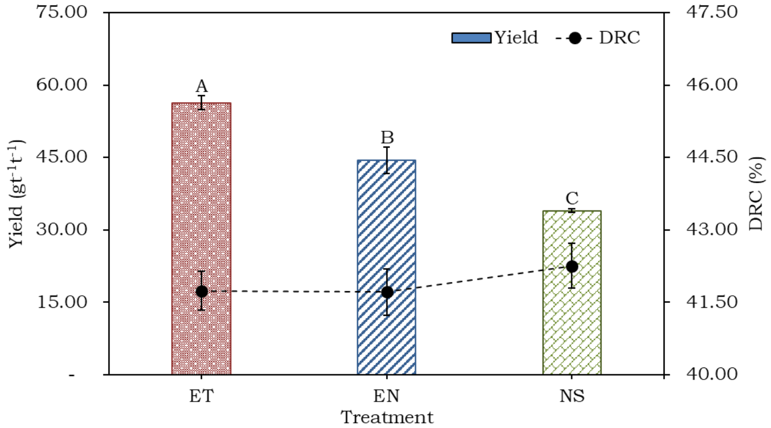

Figure 3. The average yield (column bar) and DRC (dot-line graph) each treatment after one-year research. The different uppercase letters on the column bar indicate different yield, whilst the same lowercase letters on the dot-line graph indicate not significantly different in DRC based on Tukey Comparison Method at α = 0.05. Error bars represent standard deviation

The Stability in One-Stimulant Application Cycle

As stimulants were applied once in a month, it would be eight tapping days before they were applied again. The yield pattern exhibited a negative slope to the n-tapping after application. The longer tapping practice conducted after application the lower yield were obtained (Table 1). Our results was in line with Prasana, et al (2010) which obtained fluctuating results and decreased in each tapping after application at tapping d4 intensity and several levels of stimulant concentration, while at tapping interval d7 the yield tended to be stable until the next stimulant application. All treatments showed that the first and second tapping after stimulant application generated highest yield, then decreased along with number of tapping. A significant decrease was observed in the third tapping. In ET treatment, the decrease was 30.65% to the second tapping, whilst in EN and NS treatments were 26.12% and 20.40% respectively. The lower the influence of stimulants on each tapping is possible to be positively correlated with the number of decomposed ethepone in plant tissues.

Table 1. The yield at n-tapping after stimulant application for each treatment

n-tapping after stimulant application	Yield ($gt^{-1}t^{-1}$)		
	ET	EN	NS
1	89.61 ± 12.32 a	63.38 ± 6.01 ab	46.06 ± 4.02 a
2	87.83 ± 10.49 a	65.23 ± 6.36 a	42.59 ± 3.57 a
3	60.91 ± 8.47 ab	48.19 ± 7.55 abc	33.90 ± 3.07 b
4	51.87 ± 2.22 bc	42.97 ± 2.36 bcd	28.58 ± 2.01 c
5	51.05 ± 3.03 bc	41.78 ± 2.83 cd	32.30 ± 0.92 bc
6	44.63 ± 1.79 cd	35.87 ± 2.81 de	32.40 ± 1.75 bc
7	42.29 ± 2.24 d	33.86 ± 2.15 e	29.19 ± 1.03 bc
8	39.79 ± 2.90 d	33.29 ± 3.56 e	32.38 ± 1.93 bc

Note: The different letters in the same column bar indicate significantly different yield based on Tukey Comparison Method at α = 0.05. The number after ± represent standard deviation

Table 2. The DRC at n-tapping after stimulant application for each treatment

n-tapping after stimulant application	DRC (%)		
	ET	EN	NS
1	39.71 ± 0.25	39.71 ± 0.25	39.71 ± 0.25
2	40.63 ± 1.15	40.63 ± 1.15	40.63 ± 1.15
3	42.50 ± 1.08	42.50 ± 1.08	42.50 ± 1.08
4	42.57 ± 1.98	42.57 ± 1.98	42.57 ± 1.98
5	42.29 ± 0.65	42.29 ± 0.65	42.29 ± 0.65
6	42.29 ± 0.49	42.29 ± 0.49	42.29 ± 0.49
7	41.83 ± 1.15	41.83 ± 1.15	41.83 ± 1.15
8	42.20 ± 0.35	42.20 ± 0.35	42.20 ± 0.35

Note: The different letters in the same column bar indicate significantly different DRC based on Tukey Comparison Method at α = 0.05. Error bars represent standard deviation

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The Yield and Dry Rubber Content based on Leaf Ontogenetic Development

Hevea brasiliensis presents deciduous behavior with a defoliation period of about 2–3 weeks followed by a new shoot emission. In one leave life cycle it usually takes 3 months from beginning to fall until the leaves are fully development. This new growth has high nutrient and energy requirements.

Dijkman (1951) had already observed that the lowest production period occurred when the new leaf shots were in development and competing for photosynthetic compounds. This was verified by Yeang and Paranjothy (1982) who observed a correlation between rubber production and canopy density, with low production during the re-foliation period.

The yield produced by the plant is strongly influenced by the leaf maturity (Kositsup et al, 2010). Mature leaves have a higher net photosynthesis rate than the young and immature leaves (Oktavia and Lasminingsih, 2010). However, our study showed that the yield in mature leaves had lower yield in ET and EN treatments compared to young and immature leaves, while NS showed a significant increase (Figure 4). It presumed that a long-period of high etephon concentration reduced the photosynthate stock in the laticifier tissues. In the NS treatment, the plants were able to multiply photosynthate, therefore they could generate higher yield in the mature period. This phenomena needs to be studied further.

Leaf conditions are very influential on fluctuations in latex production. Oktavia and Lasminingsih (2010) observed the production of IRR series clones in several canopy conditions which were divided into five phases, namely phase 1 when the signs of yellowing to partial yellow, phase 2 of yellow leaves were complete and some had fallen, phase 3 all leaves had fallen and new brown leaves begin to appear, phase 4 when the leaves are light green, and phase 5 when the leaves are dark green (adult phase). The results of the study showed that production in the new leaf formation phase (phase 3) was significantly lower than that of the full leaf phase (phase 5) and autumn leaves (phase 3).

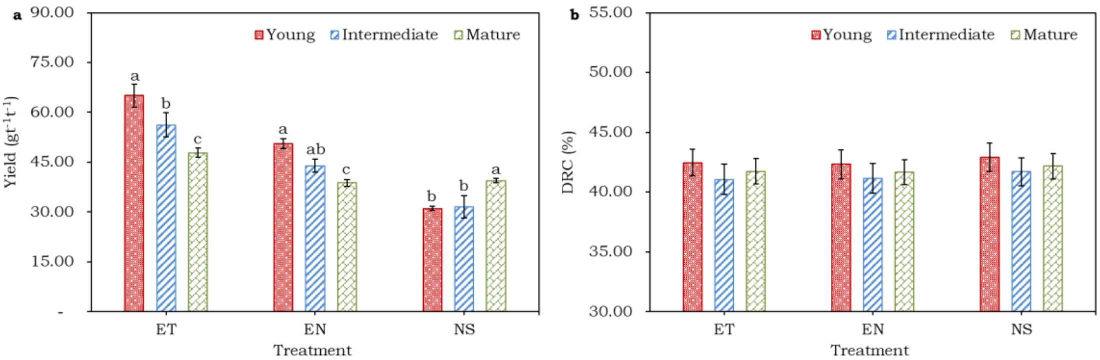

Figure 4. The average yield (a) and DRC (b) based on leaf development stage grouped into young, intermediate, and mature leaf. The different letters on the column bar indicate significantly different yield based on Tukey Comparison Method at α = 0.05. Error bars represent standard deviation

CONCLUSION

The application of high-concentration stimulant was effective to obtain latex yield in low-frequency tapping d4. Etephon strongly increased yield but might reduce the DRC. When it combined with other compounds, it lowered the effect on the yield. The first and second tapping after stimulant application would generate highest yield but would experience a decrease in the third tapping. The mature leaves had lower yield in ET and EN treatments compared to young and immature leaves, while NS showed a significant increase. This phenomena need further investigation.

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