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Effect of stimulant (ethephon) application and tapping frequency on latex production of rubber tree (*Hevea brasiliensis* Muell. Arg.)

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Abstract

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The stimulant ethephon application and tapping frequency are alternative waysto increase the latex production. The experiment was conducted to examine the effects of different dosages of ethephon and tapping frequencies on the rubber crop production. The research was conducted in district of Bengkulu province from June to August, 2016. The method used was the randomized block design (RBD) factorial with two factors; the first factor was the ethephon dosage consisting of five levels: e_0 = 0 cc trees^{-1}, e_1 = 0.3 cc trees^{-1}, e_2 = 0.6 cc trees^{-1}, e_3 = 0.9 cc trees^{-1}, and e_4 = 1.2 cc trees^{-1}, the second factor was the tapping frequency consisting of three levels: f_1 = frequency of 2 days, f_2= frequency of 3 days, and f_3 = frequency of 4 days. Therefore, there were15 combinations of treatments repeated three times. The further test used was Duncan's Multiple Range Test at 5%. The results showed that there was no interaction effect between the dosage and tapping frequency of ethephon on all observed parameters. The effect of 0.9 cc trees^{-1}ethephon doses was able to increase the flow rate of latex by 0.46 ml min^{-1}and 63% fresh latex volume, while the tapping frequency of f_3 increased latex flow rate by 0.42 ml min^{-1}and fresh latex volume by 859.8 ml. In the dry rubber content parameters, the ethephon dosing at 0.3 cc trees^{-1} produced 38.07%. On the other hand, frequency of 4 days tapping resulted 37.44% less than other treatments.

Keywords: Ethephon; frequency; latex; tapping

Introduction

Rubber plant (*Hevea brasiliensis* Muell. Arg.) is one of the leading plantation commodities that have contributed a lot in Indonesia's economy. Rubber plants in Indonesia is not only cultivated by state-owned plantations, but also cultivated by the private sector and the small holders. In the year 2014, Indonesia was the 2nd largest producing country of latex after Thailand with latex production of 2982 t. Rubber production in Indonesia is still low, reaching only 1.080 kg per ha per year compared to Thailand which reaches production 1800 kg per hectare per year, Indonesia has the largest rubber plantation in the world reaching 3.65 million ha (Subandi et al., 2018); the Directorate General of Agro Industry, 2015),

Although the area of rubber plantation is still growing,

the productivity and production of rubber in Indonesia is not increasing. This low productivity is influenced by the tapping technique that has not been efficient yet. This occurs because the tapping is done on the traditional tapping technique, after noon tapping and the routine frequency of tapping.

The rubber tapping technique used will affect the production rate of latex produced and determine the economic life of the plant. One of them is applying ethephon stimulant and set the frequency of tapping. The use of this stimulant is aimed at improving the results of latex (Setyamidjaja, 2003; Setiawan & Andoko, 2008). Stimulant ethephon or 2-chlorethyl phosphonic acid is an ethylene-producing group. If ethephonis applied to the plant tissue, ethylene gases will be able to maintain turgor pressure in the latex vessel tissue, thus increasing the duration of latex flow and increasing the in situ latex regeneration activity in rubber plants and inhibiting the occlusion of latex vessels that are cut off due to tapping (Saptono et al., 2014).

The RRIMFLOW System involves an effective and practical method for gaseous stimulation of rubber trees which in combination with the tapping of novel mini cuts (5 cm length) or of short cuts of 10 cm length on reduced frequencies (d/3 or d/4), increases the yield productivity several fold above that of trees tapped on conventional tapping and stimulation systems. The method which employs several specifically designed components involves intermittent application of a pulse of ethylene gas through a one way inflow valve into a PVC applicator fixed over an area on the bark of the rubber tree adjacent or below the tapping cut. Trees tapped 24 to 48 hours after gaseous stimulation, produce large volumes of latex over several hours of prolonged flow (Lim Chin Hock & Sivakumaran, 2003).

There is some problems caused with the RRIMFLOW system that this system is not applied in many plantations. Planters are applying the former system.

The frequency of intercepts is the time-lapse of intercepts with units of time in days (d), weeks (w), months (m), and years (y). This unit depends on the tapping system used. In adjusting the tapping frequency, the length of the incision and the intensity of tapping shall be calculated clearly and in detail. According to Siregar & Suhendry (2013) the frequency of tapping will determine the amount of production in rubber plants, especially in dry rubber (dry rubber content).

Tapping is an act of placing or cutting the latex vessels on the bark of the stem or branch of the rubber periodically so that the latex drips outward from the vessels to the bowl. Tapping is one of the main activities of rubber plantation business (Dian et al., 2017; Writer Team of Penebar Swadaya, 2008). In order to obtain a high latex result of ethephon stimulant should be combined with the frequency of tapping done, because the tapping technique is done in latex intercepts greatly affect the final quality of latex produced.

Materials and Methods

This research was done in Bengkulu Province. The materials used in this research are rubber trees planted in 2007 (10 years old), 2.5% ethephonstimulan, water, as for the tool used in this research such as tapping knife, ruler, ring, mall, tape-meter, tapping bowl, gap tapping, brusher, teapot, measuring pipette, bucket, metrolax, stationery and camera.

This research was conducted experimentally using Randomize Block Design (RBD) factorial of 2 factors. The design consisted of 15 treatments and 3 groups, to obtain 45 trial units. Each experimental unit consists of 2 plants, so the total of rubber plant used is 90 rubber plants. The treatments performed in this study were: The first factor was the ethephon dose consisting of five levels: e_0 = 0 cc tree^{-1}, e_1 = 0.3 cc tree^{-1}, e_2 = 0.6 cc tree^{-1}, e_3 = 0.9 cc tree^{-1}, and e_4 = 1.2 cc tree^{-1}, and the second factor is the tapping frequency consisting of 3 levels: f_1 = frequency 2 days, f_2 = frequency 3 days, f_3 = frequency 4 days. Supporting parameters were temperature, humidity, rainfall, lenth of Trunk circle, and Thick of the bark. The main parameters observed were latex flow rate, latex volume, and dry rubber content. Data obtained from the results of the research were analyzed using variance based on linear model. The result of significant variance analysis was tested further with Duncan Multiple Range Test at 5% level. Figures 1, 2 and 3 show the application of stimulant and the tapping.

Results and Discussion

Supporting Parameters

Climatic Circumstances during the Experiment

Observation on temperature and humidity were done every time the tapping was done. The average temperature of

Fig. 1. Stimulant application

Fig. 2. Tapping

Fig. 3. Latex accumulation

the air in the morning (at 6 am) during the study took place on average ranging between 20.69°C and 28.74°C in the early afternoon (at 14 pm).

The rainfall that occurred during the study took place around 42 mm. Rainfall is very influential on the availability of groundwater (Khoiriyah, 2014; Irsal et al., 2015). Further availability of groundwater will affect latex production. The impact of prominent climate change will affect and decrease the production. Drought is very influential on the productivity and quality of rubber products (Irsal et al., 2015). This is because climate has an important role in supporting the growth and production of crops. According to Estiningtyas et al. (2000); Subandi et al. (2017); Subandi et al. (2018a) accurate climate information is indispensable in supporting agricultural development.

Curls and Bark Thickness

The length of girth is aindication of the growth of rubber plant, because the result of rubber plant in the form of latex is processed from the bark. According to Hamzah & Gomez (1982) qoated by Koryati (2004) girth has a significant relationship with the initial volume of latex flow, total latex volume, and the blockage index (IP). The girth is an important criterion for tapping rubber plants. In the standard provision of tapering (exploitation) the girth should be 45 cm measured at a height of 130 cm from the grafting linkage with a bark thickness of at least 7 mm (Siregar & Suhendry, 2013). Rubber plant stems used in this study averaged 73.59 cm.

The thickness of leather wrapping (stem bark) in rubber plants is influenced by the gene and the type of clone rubber itself. The thickness of the bark will affect the number of latex vessels in the bark and have a positive effect on latex production (Surbakti et al., 2015). The average thickness of bark in the rubber plant used in the study was 0.98 cm.

Main Parameters

Latex flow rate (ml min^{-1})

Observation of latex rate velocity is intended to determine the latex flow pattern. At first the latex stream is fast, then slows down and eventually stops. Slow or rapid latex flow when tapped affects the high and low latex productions. The faster and longer the latex time to flow, makahasil latex is more and more. From the research conducted the pattern of latex flow for each treatment is different. The difference in latex flow patterns is caused by the many latex vessels that are cut off and the dosages of etephon are given so that the results are different.

Based on Table 1 it can be seen that giving ethephon stimulant can increase latex flow rate. Giving stimulant ethephon 0 cc tree^{-1} resulted in smaller flow rate i.e. 0.18 ml min^{-1} compared with ethephon stimulation 0.3–1.2 cc tree^{-1}. This occurs because the turgor pressure on the latex vessel cell wall lasts shorter so that the latex flow time becomes shorter and the resulting latex becomes less. Based on data of observation of latex flow rate at treatment of e_3 with dose ethephon 0.9 cc tree^{-1} tended to show highest increase from other treatment that is: 0.46 ml min^{-1}. This is because the ethephon stimulant is able to sustain a longer and more latex drainage compared to without the use of ethephon stimulants. While on treatment e_4 with dose of stimulant ethephon given 1.2 cc tree^{-1} latex flow rate did not increase and decreased. It is assumed that the dosage of etephon given is too high from the dose required to produce the maximum latex flow rate, so that the condition occurs luxury consumption and if used in a long time can cause damage to productive plants.

Table 1. Average latex flow rate (ml min^{-1}) rubber plant with various dosages of stimulant ethephon and tapping frequency

Dosage of Ethephon	Latex Flow Rate (ml min^{-1})
e_0	0.18 a
e_1	0.33 b
e_2	0.41 c
e_4	0.43 c
e_3	0.46 c
Tapping Frequency	
f_1	0.3 a
f_2	0.37 b
f_3	0.42 b

Notes: Figures marked with the same italic in the same column are not significantly different based on Duncan's test at a 5%

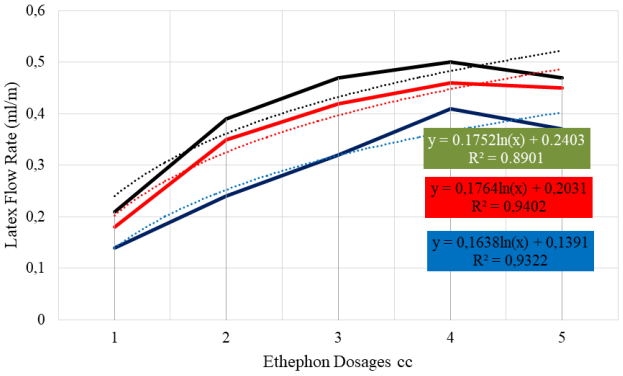

Fig. 4. Relation of Ethephon Dosages and Tapping Frequencies and Its Effect on Latex Flow Rates

Based on Figure 4 it can be seen that the dosing of the ethephon dose is very influential on the large latex flow rate. The larger the dose of etphone is given, the latex flow rate will be faster and higher, but the dosage of ethephon which is too large or excessive causes a decrease in flow rate latex. (Subronto & Harris, 1997; Lubis, 2015) states that flow velocity describes the flow of latex per unit of time per tap flow length passed by. Velocity is positively correlated with production. According to Jacob et al. (1989) in Wulandari (2015) the latex flow rate is influenced by latex flow physiology that includes a blockage index, lutoid stability and water influx in the latex flow region.

Whereas in the tapping frequency treatment performed, the f_1 treatment once every 2 days has a smaller flow rate that is: 0.3 ml min^{-1} between 3 days treatment i. e. 0.37 ml min^{-1} and 4 days i.e. 0.42 ml min^{-1}. This occurs because more intensive intercepts will result in lower flow rates due to fluid depletion in plant tissue, causing latex photosynthesis and biocynthetic processes in the tissues to be disturbed. In accordance with the views of Salisbury & Ross (1992) that water shortages in plant tissue would inhibit protein synthesis, resulting in a significant decrease in yield and even the cause of death in plants. According to Siregar (1995) tapping is too intensive to cause the disease Bround Bast (BB), which is a response from the exhaustion of plant physiology due to tapping too intensively, especially if the tapping is accompanied by the use of stimulants.

At 3-days wiretapping and 4-days wiretapping latex flow rates are increasing, this is because the latex-correction flow rate is negatively correlated with the tapping frequency. This means that the lower the intensity of tapping the latex flow rate will be higher and affect the volume of fresh latex obtained.

Fresh latex volume

In accordance with Boerhendy's (1988) assertion that the slow flow of latex during intercept has an effect on latex production. The sooner and longer the latex flows, the latex produced will be more and more. According to Siregar and Suhendry (2013), the productivity in the volume units of intercepts obtained by using ethephon stimulants should be 40% higher when compared with non-etephonated tapping. Based on the results of analysis of variance, the dosing of stimulant ethephon significantly affects to the volume of latex that dihasikan. The increase in each treatment occurred by 40%–63% in each treatment.

Table 2. Average of fresh volume (ml) of latex with varying dosages of stimulant ethephon and frequency of tapping

Dosages of Ethephon	Fresh Volume of Latex (ml)
e_0	380.22 a
e_1	691.11 b
e_2	866.67 c
e_4	912.22 cd
e_3	984.44 d
Tapping Frequncies	
f_1	636.33 a
f_2	804.67 b
f_3	859.80 c

Notes: Figures marked with the same italic in the same column are not significantly different based on Duncan's test at a 5%

Based on Table 2 it can be seen that dosing of stimulant ethephon can increase the volume of fresh latex. This can be

seen from the treatment of e_1 with dose ethephon 0.3 cc of tree^{-1} yielding latex volume equal to 691.11 ml, treatment e_2 with dose ethephon 0.6 cc tree^{-1} yielding latex volume equal to 866.67 and treatment e_3 with administration dose ethephon 0.9 cc tree^{-1} yielded a volume of 984.44 ml, in the treatment e_3 (0.9 cc tree^{-1}) showed the best results compared to other dosages. Allegedly giving stimulants to rubber plants that can boost latex production of rubber plants. In accordance with the opinion of Siregar & Suhendry (2013) that the provision of stimulant serves to extend the latex drainage through cell physiology by maintaining a high pressure of turgor in the tissue so that the production of latex obtained more than without stimulants. However, in treatment e4 with dose ethephon 1.2 cc tree^{-1} the volume of latex obtained decreased ie 912.22 ml, this occurs because each rubber plant has a maximum latex flow rate, so even though the higher dosages of etephon did not affect the volume resulting from.

While in the tapping frequency (wireline) treatment performed, the 4-day tapping frequency treatment gives the highest volume of latex which is 859.8 ml, when compared with the 3-day frequency treatment reaches 804.67 m and the 2-day frequensy yields the latex volume of 636.33 ml. It has been explained in the latex flow rate, that the lower the tapping intensity the higher the latex flow rate will be. This occurs because the plant does not experience stress from the depletion of water in the tissues so that the biosynthesis of enzymes, sucrose, and proteins in the vascular tissue is not disturbed, so with lower intensity tapping will produce larger latex volumes than the high intensity of tapping.

Here is a graph of the relationship between the doses of etephon given by the tapping frequency performed.

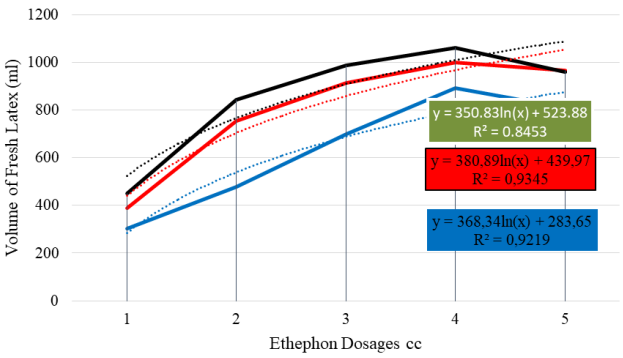

Fig. 5. The graph of the ethephon dosage and the frequency of tapping effect on fresh volume of latex

Based on Figure 5 it can be seen that the relationship between the dose ethephon and the above tapping frequency can be concluded that the dosage of ethephon correlates positively to the amount of latex volume produced. This means that the higher dosage given ethephon, then the volume of latex obtained more. The frequency of tapping is negatively correlated to the volume of latex produced. This means that the more intense the frequency of tapping that is done to eat the latex volume that gets lower.

Dry Rubber Content (%)

The dry rubber content is a heavy solid rubber content computed in percent (%). This dry rubber content becomes a determinant in rubber selling price. Handling of results in both latex and coagulant determines the value of dry rubber content (DRC). Some of the factors that may affect the field of dry rubber content such as: tapping techniques, climate (rain or not), leaves of the plant (autumn leaves or leaf growth stage in the canopy), clones, use of stimulants. Giving the stimulant gives a considerable influence on the percentage of the DRC (Siregar & Suhendry, 2013).

Table 3. Average dry rubber content (%) of rubber plant with various dosage of stimulant ethephon and frequency of tapping

Dosages of Ethephon	Dry Rubber Content (%)
e_4	31.61 a
e_3	35.24 b
e_2	36.91 c
e_1	38.07 d
e_0	39.57 e
Tapping Frequencies	
f_1	35.41 a
f_2	35.99 a
f_3	37.44 b

Notes: Figures marked with the same italic in the same column are not significantly different based on Duncan's test at a 5%

Based on the analysis of variation of dose ethephon and tapping frequency, there was no interaction at the resulting dry rubber content (Figure 6).

Description: Figures marked with the same small letters in a single column are not significantly different according to Duncan's advanced test at a 5%.

Based on the analysis of variation of dose ethephon and tapping frequency, there was no interaction in the resulting dry rubber content. In Table 3 it was shown that dosing etephere and tapping frequency had a negative effect on the percentage of rubber content, which in the treatment of e_0

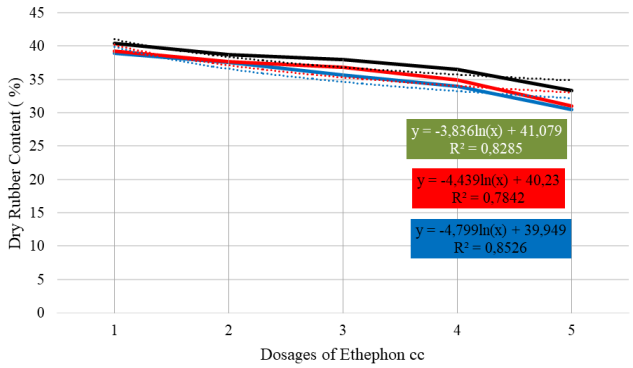

Fig. 6. The graph of the ethephon dosage and the frequency of tapping effect on dry rubber content

without giving ethephon gave a larger percentage of 39.57%, followed by treatment with 0.3 cc dose of tree^{-1} i. e. 38.07%, e_2 with dose 0.6 cc of tree^{-1} that is: 36.91%, e_3 with giving dose 0.9 cc tree^{-1} that is: 35.24%, and at treatment e_4 that is by giving dose ethephon 1.2 cc tree^{-1} shows the lowest DRC value that is equal to 31.61%. In accordance with the results of research conducted by Fahmi et al. (2015) that the higher dose ethephon given the value of DRC percentage will decrease. In the tapping frequency treatment, the frequency treatment of tapping two days once showed a lower DRC value which is about 35.41% , significantly different from the frequency of tapping treatment once every 4 days that reach 37.44%, but not significantly different in wiretapping frequency treatment once every 3 days which is about 35.99%.

The low percentage of these treatments, presumably caused by the influence of dosages of ethephon, is too large. The decrease in the DRC presentance occurring at the time of this study is in line with Siregar and Suhendry's (2013) opinion that giving stimulants can reduce the percentage of dry rubber content by 3%. From the results of the analysis there was a decrease in dry rubber content occurred in each treatment? Here is a graph of the relationship between the given dosage ofethephon and the frequency of tapping applied.

Based on Figure 5 relationship between the dosage ofethephon and the tapping frequency is quadratic, and the relationship between the effect of dosage of ethephon inversely on the dryrubber content, meaning the greater the dosageethephon given the dry rubber content is lower, as well as the relationship between the frequency of tapping on the percentage value of rubber content, the more intensive the rubber tapping frequency is, the percentage of the dry rubber content is lower.

The dry rubber content is a measurable parameter indicating the percentage of rubber amount contained in latex. So the higher the rubber content in latex means that the distance of the rubber molecule in the latex is closer and the amount of water in the latex is less, whereas the lower the rubber content in the latex means the amount of water contained in the latex is greater and the distance between the latex molecules in the latex goes further (Kunjet et al., 2013; Sainoi, & Sdoodee, 2012; Elly, 2006).

Conclusion

Based on the results of research conducted it can be drawn conclusion as follow. Application of ethephon dosage and tapping frequency did not showed any interaction. Dosage of ethephon 0.9 was able to increase latex flow rate to 0.46 ml min^{-1} and fresh latex volume equal to 63% that is: 984.44 ml, and 4 day tapping frequency increase latex flow rate equal to 0.42 ml min^{-1} and fresh latex volume of 859.8 ml. Treatment of ethephon dosage of 0.3 cc of tree^{-1} yielded the dry rubber content better than the dosages of ethephon other than 38.07% and frequency treatment of tapping 4 days once give the highest percentage value of highest dry rubber that is equal to 37.44%, compared with other treatments.

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