Roles of PEG based Alternative Stimulant to Increase Latex Yield and Renewable Bark Recovery of Clones PB 260 6 Years Old

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Keywords: Stimulant, PEG, Clone PB 260.

Abstract: The research was aimed to obtain PEG based alternative stimulant formulation to increase Latex yield and accelerate renewable bark recovery of clone PB 260. This research was conducted at PTPD Paya Pinang Plantation, LauTador, in Tebing Tinggi, Regency of Deli Serdang, North Sumatera. The research site is at 25 m above sea level with *Ultisol* soil type. This research is to study the difference of observation variable of g/p/s, bark thickness, number of latex vessels, plugging index. The results showed that stimulant had significant effect on the production of g/p/s, and very significant effect on bark thickness, number of latex vessels and plugging index. PEG applications increase production of g/p/s, bark skin, number of latex vessels, plugging index. The combination of stimulant and PEG has very significant effect on the production of g/p/s, bark thickness, plugging index.

1 INTRODUCTION

Rubber tree (*HeveabrasiliensisMuell, Arg*) is the main source of natural rubber and large foreign exchange income source. In the future, the prospect of natural rubber is still good, as indicated by increasing trend of natural rubber consumption (Anwar, 2012; Boerhendhy, 2013).

Indonesia's opportunity to become the world's largest producer of natural rubber is quite large due to adequate resources to increase production. Increased production can be achieved among others by using superior clones and optimization of tapping system. One of the optimization of tapping system is the use of stimulants to increase rubber productivity and business efficiency (Andriyanto and Darojat, 2016).

Stimulants can increase production by slowing latex flow in latex vessels.

Stimulants applied to plant tissues can stabilize *lutoid* which is the basic traction of latex and contains many cautions. *Lutoid* stabilization is crucial because if the *lutoid* ruptures, the cautions will react with negative rubber particles and resulting coagulation. Coagulation process causes the latex to stop dripping (Krishnakumaret al, 2011). Due to the reason, the purpose of stimulants application is to delay coagulation of latex vessels and latex mass flow is longer.

Acceleration of bark recovery is very important particularly for superior clones of PB 260. Such clone is Quick Starter which has some specific properties such as high initial production, less responsive to stimulants, thin renewable bark and fast exploitation system. The economic life of clone PB 260 is 17 years (Rahayu, 2017).

In addition,renewable bark recovery is essential to support and at the same time create good conditions for adjacent panels (panel BO-2) (Sumarmadji, et al., 2012). This certainly can prevent the occurrence of dry tapping grooves for sufficient nutritional intake in panel BO-2 with rapid bark recovery in panel BO-1.

PEG (Polyethylene glycol) is a compound that can decrease osmotic potential through sub unit ethylene oxide activity that increase water molecules through hydrogen bond and potentially used as stimulant material.

Rahayuet al (Rahayuet al,2016) was reported that PEG application as stimulant can increase latex production.Rahayuet al (Rahayuet al,2017) also revealed that PEG can increase latex production and increase bark thickness of 11 years old of clone PB 260.

The aim of this research is to study PEG as an

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alternative stimulant to increaselatex production and accelerate renewable bark recovery and thickness in 6 years old of clone PB 260.

2 RESEARCH METHODS

This research was conducted at PTPD Paya Pinang Plantation, LauTador, in Tebing Tinggi, Regency of Deli Serdang, North Sumatera. The research site is at 25 m above sea level with *Ultisol* soil type.

The research is 2 factors Randomized Block Design. The factor treatment is stimulant concentration (S), consisted of 4 treatment levels namely S_0 = no stimulant, S_1 = N_2O_1 formulation, S_2 = Etephon 1.5% + N_2O_1 formulation, S3 = 2.5% etephon + N_2O_1 formulation and PEG concentration (P) consisted of 2 levels namely P_0 = no PEG, P_1 = PEG 3%.

3 RESULTS AND DISCUSSION

3.1 Latex Yield (g/p/s)

Latex yield is measured by the volume of latex per tree per tapping and then converted to dry production in grams per tree per tap (g/p/s) after multiplying by the Total Solid Content (TSC). The results showed that application of Stimulant (S) has significant effect on Latex production.

Application of PEG (P) also has significant effect on Latex production. Combination of Stimulant (S) and PEG (P) had very significant effect on latex production (Table 1).

Table 1: Mean of Latex Production (g/p/s) on Treatment of Stimulant and PEG at 6 years old of Clone PB 260.

Treatment	Latex Production (g/p/s)
Stimulant	
S_0 (control)	30.47 d
S_1 (N_2O_1formulation)	35.79aA
S_2 (Etephon 1,5% + N_2O_1 formulation)	31.43 c
S_3 (Etephon 2,5% + N_2O_1 formulation)	33.12 b
PEG	
P_0 (control)	26.85bB
P_1 (PEG 3%)	38.55aA
Interaction	
S_0P_0	29.00hH
S_0P_1	37.23cC
S_1P_0	27.33fF
S_1P_1	44.26aA
S_2P_0	29.88eE
S_2P_1	32.98dD
S_3P_0	26.49gG
S_3P_1	39.74 Bb

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% Duncan test level and 1% (N_2O_1 : NAA 100 ppm + kinetin 50 ppm + palmitic acid 2%)

Table above shows that stimulant treatment has significant effect on latex production. The highest latex production is found at S_1 treatment namely N_2O_1 formulation at 35.79 g/p/s, while the lowest is on S_0 treatment (control) at 30.47 g/p/s. In this case, there is an increase in latex yield by 17.45% with application of N_2O_1. PEG application also had significant effect on latex yield that is an increase of latex yield by 43.57%.

The combination of stimulants and PEG had significant effect on latex yield. The highest latex yield was found at S_1P_1 treatment (N_2O_1 and PEG formulations), while the lowest was S_0P_0 (control). Increased latex yield by application of N_2O_1 and PEG formulations is 52.62%.

Interaction of stimulant S_1 treatment (N_2O_1 formulation) and PEG show significantly increased of production. This is because the formulation material is containing palmitic acid (fatty acid). In *glycolysis* process, such palmitic acid would be converted into Acetyl Coenzym A. Such Coenzym will form *Tricarboxilie* Acid (TCAs) which will produce energy. The energy is used for vegetative growth (stem cell enlargement) that is the addition of brak thickness and the number of latex vessels. Some of Acetyl Co A will produce *terpenoid* compounds such as *polyterpenes* (latex). Therefore, application of a stimulant containing *palmitic* acid causes increasing the production of latex (Rahayuet al, 2017).

In addition, PEG application will maintain the osmotic potential stability and moisture content in plant cells which will help to increase the turgor pressure in the plant (Rouhi and Surki, 2011; Rahayuet al., 2017). Availability of water in the cells will help increase cell division followed by increased bark thickness and number of latex vessels.

Ariefet al (Ariefet al,2010) reported that conditioning treatment with PEG 300 gl^{-1} can increase the growth of soybean. The maintained

moisture content in the cells will increase turgor. Increasing number of latex vessels and turgor pressure will encourage production. Thus, PEG application will increase latex production (Rahayuet al., 2017; Rahayu, 2017; Rahayuet al., 2017).

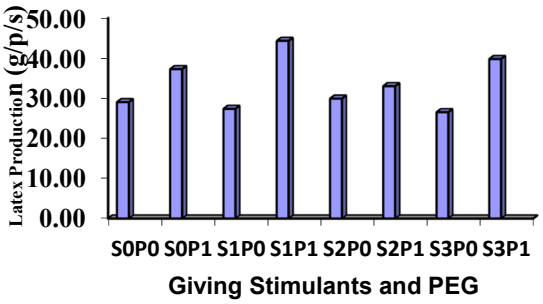

Figure 1: Histogram of Latex Production with combination of Stimulant and PEG Treatment on 6 years old of clone PB260.

3.2 Bark Thickness (mm)

Bark is the main capital of rubber cultivation. Therefore efforts should be conducted to make renewable bark can be recovered well so that can be tapped again. The statistic analysis results showed that Stimulant (S) and PEG (P) have significant effect on bark thickness. Combination of Stimulant (S) and PEG (P) application also has very significant effect on bark thickness (Table 2).

Table2: Mean of Bark Thickness (mm) on Treatment of Stimulant and PEG at 6 years old of Clone PB 260.

Treatment	Bark Thickness (mm)
Stimulant	
S_0 (control)	2.27bB
S_1 (N_2O_1 formulation)	2.41aA
S_2 (Etephon 1,5% + N_2O_1 formulation)	2.33bB
S_3 (Etephon 2,5% + N_2O_1 formulation)	2.32bB
PEG	
P_0 (control)	2.28bB
P_1 (PEG 3%)	2.38aA
Interaction	
S_0P_0	2.20cC
S_0P_1	2.35bB
S_1P_0	2.31bB
S_1P_1	2.51aA
S_2P_0	2.34bB
S_2P_1	2.32bB
S_3P_0	2.29bB
S_3P_1	2.34bB

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% Duncan test level and 1%(N_2O_1 : NAA 100 ppm + kinetin50 ppm + palmitic acid 2%).

The table above shows that stimulant application has very significant effect on renewable bark thickness. The highest bark thickness found in S_1 treatment, namely application of N_2O_1 at 2.41 mm. The lowest is found at S_0 treatment (control) namely 2.27 mm, an increase by 6.17% with N_2O_1 application. Application of PEG is also significantly affect the thickness of renewable bark.

The combination of stimulant and PEG had significant effect on the thickness of renewable bark. The highest thickness of renewable bark was found in S_1P_1 treatment (N_2O_1 formulations and PEG). The lowest thickness of renewable bark was found in the treatment of S_0P_0 (control). Increased thickness of renewable bark by application of N_2O_1 formulation and PEG is 14.09%.

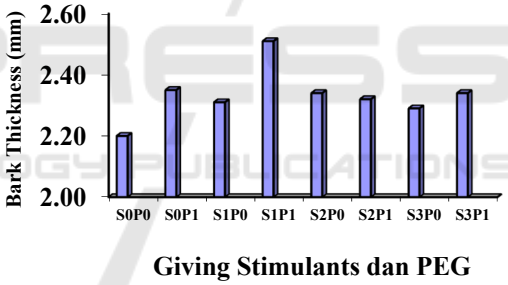

Figure 2: Histogram of Renewable Bark Thicknesswith combination of Stimulant and PEG Treatment on 6 years old of clone PB 260.

3.3 Number of Latex Vessel

The results showed that stimulant and PEG treatment have very significant effect on the number of latex vessels. The combination also has very significant effect on the number of latex vessels (Table 3).

Table 3: Means of the Number of Latex Vessels on Stimulant and PEG Treatment at 6 years old of Clone PB 260.

Treatment	Number of Latex Vessel
Stimulant	
S_0 (control)	10.58bB
S_1 (N_2O_1 formulation)	11.74aA
S_2 (Etephon 1,5% + N_2O_1 formulation)	11.41abAB
S_3 (Etephon 2,5% + N_2O_1 formulation)	10.96bB
PEG	
P_0 (control)	10.44bB
P_1 (PEG 3%)	11.91aA
Interaction	
S_0P_0	9.80
S_0P_1	11.35
S_1P_0	10.80
S_1P_1	12.69
S_2P_0	10.91
S_2P_1	11.91
S_3P_0	10.24
S_3P_1	11.69

Note:The numbers followed by the same letter on the same row or column are not significantly different at the 5% Duncan test level and 1%(N_2O_1 : NAA 100 ppm + kinetin50 ppm + palmitic acid 2%).

The table above shows that stimulant application has very significant effect on the number of latex vessels. The highest number of latex vessels was found in S_1 treatment (N_2O_1 formulation) namely 11.74,while lowest found at S_0 (control) namely 10.58. Increasing the number of latex vessels by N_2O_1 is10,96%. PEG application also has very significant effect on the number of latex vessels that is an increase by 14.08%.

The combination of stimulant and PEG did not significantly affect the number of latex vessels. However, there is a tendency for the largest number of latex vessels to be found in S_1P_1 treatment (N_2O_1 and PEG 10%), while the lowest number is found in the S_0P_0 treatment (control). Increasing number of latex vessels by stimulant (control) and PEG is 29,49%.

Table 2 and 3 show that N_2O_1 application of increases bark thickness and number of latex vessels. This is because N_2O_1 formulation is containing *auxin* (NAA) and *cytokinin* (kinetin) along with *palmitic* acid. The synergism of both hormones can lead to cell division, enlargement, and cell differentiation, especially in the rubber stems which resulted in the thickening of the bark and the number of latex vessels. Rahayuet al (Rahayuet al,2016) reported that the application of NAA + kinetin can increase the bark thickness and the number of latex vessels. Koryati (Koryati,2016) also found that the administration of *auxin* hormone (IAA) and kinetin may affect the bark thickness and the number of latex vessels in various clones.

In other hand, the *palmitic* acid in the formulation will be converted to Acetyl Co A as important precursor in primary and secondary metabolism. In primary metabolism, Acetyl CoA will enter to *Tricarboxilyc* Acid (TCA) cycle that will produce energy (ATP) where the energy (ATP) will be used by plants for vegetative growth such as increases the bark thickness and the number of latex vessels (Rahayuet al, 2016; 2017).

PEG application is capable to maintain osmotic potential and water content in plant cells (RouhiandSurki, 2011, Rahayu, 2017). In addition, PEG works optimally in the process of entering water into cells and thus will increase and spur cell division followed by the addition of cell number and size (cells enlargement) (Sufinoris, 2009;Susanti, 2014). Thus the provision of PEG here can help increase the bark thickness and the number of latex vessels.

3.4 Pluging Index (IP)

The result of statistic analysis showed that stimulant and PEG treatment have very significant affect on plugging index. The treatment combination also has significant affect on the plugging index (Table 4).

Table 4: Mean of Plugging Index on Stimulant and PEG Treatment at 6 years old of Clone PB 260.

Treatment	Pluging Index (IP)
Stimulant	
S_0 (control)	7.15 bB
S_1 (N_2O_1 formulation)	6.12 dD
S_2 (Etephon 1,5% + N_2O_1 formulation)	7.53 aA
S_3 (Etephon 2,5% + N_2O_1 formulation)	7.08 cC
PEG	
P_0 (control)	7.29 aA
P_1 (PEG 3%)	6.60 bB
Interaction	
S_0P_0	8.04 a
S_0P_1	6.27 e
S_1P_0	6.43 d
S_1P_1	5.61 f
S_2P_0	7.62 b
S_2P_1	7.44 b

S_3P_0	7.10 c
S_3P_1	7.07 c

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% Duncan test level and 1%(N_2O_1 : NAA 100 ppm + kinetin 50 ppm + palmitic acid 2%)

The table shows that stimulant application (S) has very significant effect on the plugging index (IP). The lowest plugging index was found in S_1 treatment with application of N_2O_1 formulation, and the highest on S_2 treatment with etephon 1.5% + N_2O_1 formulation. The decrease in the plugging index by application of N_2O_1 formulation compared with control (S_0) is 23,04%. PEG application has very significant effect on the 23,04 index that is lowering the 23,04index by 10.45%.

The combination of stimulant and PEG has significant effect on the plugging index. The lowest plugging index was found in S_1P_1 treatment (N_2O_1 formulation and PEG), while the highest found in S_2P_1 treatment. The decrease in the block index by application of N_2O_1 and PEG formulation compared with the controls is 43,32%.

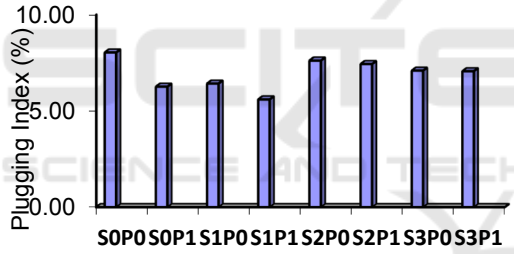

Figure 3: Histogram of Plugging Indexwith combination of Stimulant and PEG Treatment on 6 years old of clone PB 260.

The decrease in plugging index with N_2O_1 formulation is caused by increased energy from the *palmitic* acid contained in the formulation. Such acid will produce ATP (energy) derived from Tricarboxylic acid (Respiration). ATP will be used as a source of energy for the formation of *Iso Pentenyl Pyrofospat* (IPP) which will produce isoprene (latex) (Rahayuet al, 2017; Rahayuet al, 2017).

Accordingly, Zulhilmiet al (Zulhilmiet al,2012) confirm that photosynthesis activity will increase with the provision of PEG so that NADH-oxidase is also increases. Increased NADH-oxidase is followed by increased Super Oxide Dismutase (SOD) enzymes that play a role in stabilizing *lutoid*. Stable lutoid will decrease the plugging index so latex will flow and latex production becomes increased (Rahayuet al, 2017; Rahayu, 2017).

Accordingly, Sumarmadji (Sumarmadji,1999) states that if the production increases the plugging index will decrease, in other words plugging index is negatively correlated with production.

4 CONCLUSION

1. Stimulant application is significantly lead to increased production; reduce plugging index, increase bark thickness and number of latex vessels.
2. PEG application also encourage increased production (g/p/s), bark thickness, number of latex vessels and decreasing the plugging index
3. The combination of stimulant and PEG increase latex production, bark thickness and the number of latex vessels, and decreasing the plugging index.

REFERENCES

Andriyanto, M dan Darojat, M.R. 2016. Potensi Polyethylen Glycol (PEG) sebagai Stimulan Lateks pada Tanaman Karet (*Heveabrasiliensis* Muel.Arg). Agrovigor 9(1).

Anwar, C. 2012. Prospek Karet Masih Bagus. Media Perkebunan Edisi 106. November 2012, 68-69.

Arif, M., Tariq, M., Khan, M.U and Munir, I. 2010. Effect of Seed Prinning on Growht Parameter of Soybean. *J Bot*. 43(4). 2803-2812.

Boerhendhy, I. 2013. Penggunaan Stimulan Sejak Awal Penyadapan untuk Meningkatkan Produksi Klon IRR 39. Jurnal Penelitian Karet, 2013, 31(2):117-126.

Koryati, T. 2016. Upaya Mempercepat Matang Sadap dan Karakter Produksi Lateks Beberapa Klon Karet melalui Penggunaan Zat Pengatur Tumbuh. *Disertasi* Program Doktor Ilmu Pertanian. Pascasarjana Fakultas Pertanian Universitas Sumatera Utara.

Krishnakumar, R., R.L. Helen., P.K. Ambily dan J. Jacob. 2011. A Modified Stimulation Method in Heveabrasiliensis for Reducing Oxidative Stress. IRRDB International Rubber Conference Thailand, 15-16 Dec 2011.

Rahayu, M.S., Siregar. L.A.M., Purba, E., Tistama, R. 2016. Pengaruh Waktu Aplikasi dan Pemberian PEG TerhadapProduksiKaret (*Heveabrasilliensis*Muel.Arg) pada Klon PB 260. Prosiding Seminar Nasional PERAGI. Bogor.

Rahayu, M.S. 2017. Peran Zat Pengatur Tumbuh, Oleokimia dan PEG dalam Meningkatkan Produksi dan Mempercepat Pemulihan Kulit Tanaman Karet Klon PB 260. *Disertasi*, Program Doktor Ilmu-Ilmu Pertanian Pascasarjana Fakultas Pertanian Universitas Sumatera Utara Medan.

Rahayu, M.S., Siregar. L.A.M., Purba, E., Tistama, R. 2017. Pengaruh Stimulan Berbahan Pemulih Kulit dan PEG (Polyetilen Glikol) Terhadap Pertumbuhan Kulit Pulihan dan Produksi Tanaman Karet (*Heveabrasilliensis*Muel.Arg) Klon PB 260. International Journal of Science and Research Methodology.

Rahayu, M.S., Nurhayati., Tistama, R., Asbur, Y. 2017. The Role of PEG Based Stimulant Application on The Production and Physiology Character of Clone PB 260. International Journal of Sciences: Basic and Applied Research.

Rouhi, H.R. and Surki, A.A. 2011. Study of Different Priming Treatments on Germination Traith of Soybean Lots Biol Sci. 3(1). 101-108.

Sufinoris. 2009. PeningkatanViabilitas (Priming) Benih Kapas (*Gossypium hircatum* L.) dengan Polyethylene Glycol (PEG) 6000. Skripsi diterbitkan. Malang: UIN Maliki Malang.

Sumarmadji. 1999. Respon Karakter Fisiologi dan Produksi Lateks Beberapa Klon Tanaman Karet Terhadap Stimulan Etilen. Balai Penelitian Sungei Putih dan Badan Penelitian dan Pengembangan Pertanian.

Susanti, E. 2014. Pengaruh Osmoconditioning dengan PEG (Polyethylene Glycol) 6000 Terhadap Viabilitas Benih Kenaf (*Hibiscus cannabisius* L.). Fakultas Sains dan Teknologi. Universitas Islam Negeri Maulana Malik Ibrahim, Malang.

Zulhilmi; Suwirmen; Surya, W.N. 2012. Pertumbuhan dan Uji Kualitatif Kandungan Metabolit Sekunder Kalus Batang (*Spilanthesacmella*Murr.) dengan Penambahan PEG untuk menginduksi Cekaman Kekeringan. Jurnal Biologi, Universitas Andalas. September 2012:1-8.