International Journal of Engineering & Technology, 7 (4.15) (2018) 465-468

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

PEG Based Alternative Stimulants and the Effect on Latex Production and Physiology of 6 Years Old of Clone PB 260

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Abstract

The objectives of this study is to study formulation of PEG based alternative stimulant to increase latex production and physiologically safe for clones PB 260. This research was conducted at *Sungei Putih* Research Center, Rubber Research Center, Deli Serdang Regency, Province of North Sumatera and PTPD Paya Pinang, Tebing Tinggi, North Sumatera. The study uses 6 year-old of rubber clone PB 260 to determine differences in some parameter such as production (g/p/s), inorganic phosphate, sucrose and thiol levels. The results showed that stimulants have significant effect on production (g/p/s) and inorganic phosphate. PEG applications can encourage increased production (g/p/s) and inorganic phosphate. The combination of stimulant and PEG has very significant effect on production (g/p/s) and inorganic phosphate.

Keywords: *PEG, Rubber, Production*

1. Introduction

Tapping is rubber tree harvesting to obtain maximum and sustainable production. Rubber trees are expected able to continuously produce latex without disturbance. The common disturbance is not produce latex at the time of tapping. This is often referred to as dry tapping grooves (KAS)[1].
High production can be achieved by appropriate exploitation system in rubber tree. Generally, farmers use stimulant to increase latex production but without considering exploitation intensity. The use of stimulant is reasonable because more efficient and faster in increasing latex production [2].
Currently, planters widely used ethepon based stimulants [3]-[4]. The use of ethepon can lead to increased production by delaying the occurrence of coagulation causing plugging in latex vessels which resulting longer latex flowing[5].
In addition to stabilizing lutoid, the use of ethepon stimulant will increase pH in cytosol or known as alkalinization which affects latex stability and prevent (delay) coagulation, and when combined with adequate water supply causes longer latex flow[6].
However, long term use of these stimulants can decline plant health and may trigger physiological stress due to excessive stimulation and not suitable with the clone characters. If this continues, it can cause dry tapping grooves which will decrease latex production[2]-[7].
Rahayu et al (2017) [7] found that PEG based alternative stimulants can increase latex production and not disrupt plant physiological conditions on 11 years old of clone PB 260.
Accordingly, research on PEG based alternative stimulants have been conducted on 6 years old of clone PB260.

2. Methodology

This research was conducted at Sungei Putih Research Center, Rubber Research Center, Deli Serdang Regency, Province of North Sumatera and PTPD Paya Pinang, Tebing Tinggi, North Sumatera. The study uses 6 year-old of rubber clone PB 260.
The research is Factorial Randomized Block Design with 2 factors treatment and 3 replications. The factor is stimulant concentration (S), consisted of 4 treatment levels namely S_0 = no stimulant, S_1 = N_2O_1 formulation, S2 = Etephon 1.5% + N_2O_1 formulation, S3 = 2.5% etephon + N_2O_1 formulation and PEG concentration (P) consisted of 2 levels of treatment namely P_0 = no PEG, P_1 = PEG 3%
The number of experiment units was 24 and each unit consisted of 5 trees. Thus, total number of tree is 120 with a planting distance of 5 x 2.5 meters. Planting area was selected based on criteria namely 6 years old of clone PB 260, then divided into 3 groups as replications. Each experimental unit contains 5 trees in close proximity and marked with paint to avoid observation errors.

3. Result and Discussion

Latex Production (g/p/s)

Data of Latex production is measured by latex volume per tree and then converted to dry production in grams per tree per tap (g/p/s) after multiplying by Total Solid Content (TSC). The results showed that Stimulant (S) had significant effect on latex production. PEG (P) application has very significant effect on latex production. The combination of Stimulant and PEG is very significantly affecting latex production (Table 1).

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

Treatment	Latex production (g/p/s)
Stimulant	
S_0 (control)	29.45 d
S_1 (Formulation N_2O_1)	34.77 a
S_2 (etephon 1,5%+ Formulation N_2O_1)	30.41 c
S_3 (etephon 2,5%+ Formulation N_2O_1)	32.10 b
PEG application	
P_0 (control)	25.83 bB
P_1 (PEG 3%)	37.53 aA
Interaction	
S_0P_0	27.98 hH
S_0P_1	36.21 cC
S_1P_0	26.31 fF
S_1P_1	43.24 aA
S_2P_0	28.86 eE
S_2P_1	31.96 dD
S_3P_0	25.47 gG
S_3P_1	38.72 bB

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% and 1% Duncan test. N_20_1 (NAA 100 ppm + Kinetin 50 ppm + Palmitic Acid 2%).

Table 1 shows stimulant treatment had significant effect on latex production. The highest latex production was found in S_1 treatment (N_2O_1 formulation) namely 34.77 g/p/s, while the lowest in treatment S_0 (control) namely29.45 g/p/s. In this case there is an increase in latex production by 18.06% with bark recoverer formulation N_2O_1. PEG application also had very significant effect on increasing of latex production, that is an increase by 45.29%.
Combination of stimulant and PEG had very significant effect on latex production. The highest latex production was found in S_1P_1 (formulations N_2O_1 and PEG), namely 45.29%. This is because PEG able to maintain water content stability in plant cells which increase turgor. Given that latex production is strongly influenced by turgor pressure, the presence of PEG can increase latex production [8]-[4]
In other hand, Palmitic acid (fatty acid) contained in N_2O_1 is material base for Acetyl Co A.In Secondary metabolism, Acetyl CoA will produce terpenoid compounds such as politerpenoid (latex). Therefore, application of palmitic acid stimulants basis is able to increase the latex production [9]-[7].

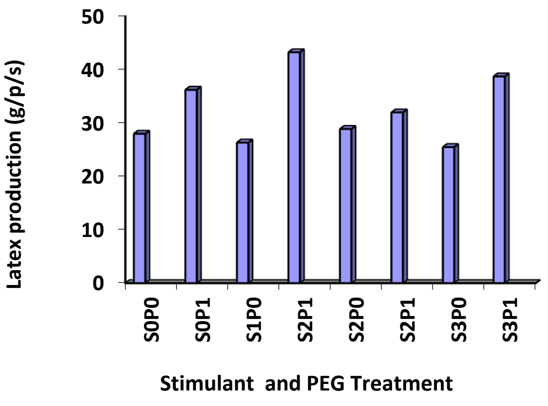

Fig.1. Histogram of Mean of Latex Production by Stimulant and PEG Treatment on 6 years old of clone PB 260

Inorganic Phosphate (mM)

Level of Inorganic phosphate indicates intensity of metabolic activity in latex vessels[10]. The results showed that stimulant (S) treatment had no significant effect on Inorganic Phosphate (FA). PEG (P) application has very significant effect on Inorganic Phosphate (FA). Combination of the stimulant treatment (S) and PEG had very significant effect on Inorganic Phosphate (FA) (Table 2).

Table 2. Mean of Inorganic Phosphate (mM) by Stimulant and PEG Treatment on 6 years old of clone PB 260

Treatment	Inorganic Phosphate
Stimulant	
S_0 (control)	3.19
S_1 (Formulation N_2O_1)	3.17
S_2 (etephon 1,5%+Formulation N_2O_1)	3.16
S_3 (etephon 2,5%+ Formulation N_2O_1)	3.20
PEG application	
P_0 (control)	3.04 bB
P_1 (PEG 3%)	3.32 aA
Interaction	
S_0P_0	3.34 bB
S_0P_1	3.04 dD
S_1P_0	2.74 eE
S_1P_1	3.60 aA
S_2P_0	3.23 cC
S_2P_1	3.10 cC
S_3P_0	2.86 eE
S_3P_1	3.55 aA

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% and 1% Duncan test. N_20_1 (NAA 100 ppm + Kinetin 50 ppm + Palmitic Acid 2%)

Table 2 shows PEG treatment had significant effect on Inorganic Phosphate (mM). The highest Inorganic Phosphate (mM) was found in P_1 treatment namely 3.32mM, while the lowest in treatment P_0 (control) namely3.04 mM. In this case there is an increase in Inorganic Phosphate (mM) by 9.21% withPEG application.
Combination of stimulant and PEG also had very significant effect on Inorganic Phosphate (FA). The highest latex production was found in S_1P_1 (formulations N_2O_1 and PEG), namely 3.60 mM. This is because PEG application will increase PEP carboxylase and in turn increasing photosynthesis activity. Increased photosynthesis will be followed by increase in carbohydrates. Carbohydrate is the main source of raw materials for any processes in plants, including secondary metabolic process. Such process produces terpenoids (latex) so that PEG application increases latex production as shown in table 1[11]-[12]-[7]. Woelan et al., (2013) [13] state that high levels of Inorganic phosphate will support the ongoing metabolic processes of plants, especially those related to latex biosynthesis.
In addition, palmitic acid contained in this stimulant formulation can produce energy (ATP) obtained from Tricarboxylic Acid (Respiration). The resulting ATP shows active metabolism for latex formation [4]. Lacote, et al., (2010) [10] state that the levels of Inorganic Phosphate are indicate the intensity of metabolic activity in latex vessels.
Higher levels of Inorganic Phosphate means more active metabolism in the plant. In general, levels of Inorganic Phosphate in both treatments are in safe conditions and not exceeded the threshold. The maximum level of inorganic phosphate is 25 mM. It means that if the level exceeds the threshold, plants will experience stress or disease[14].

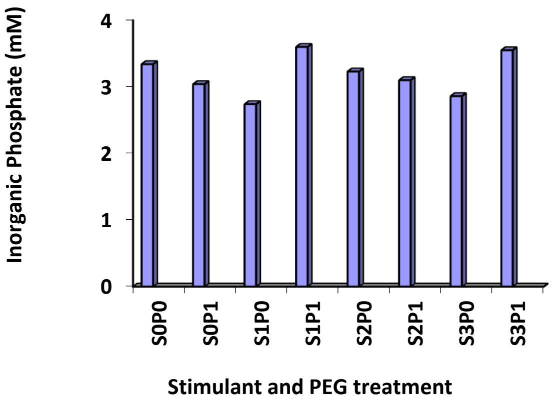

Fig. 2. Histogram of Mean of Inorganic Phosphate (FA) by Stimulant and PEG Treatment on 6 years old of clone PB 260

Sucrose (mM)

Statistical analysis showed that either stimulants (S) or PEG (P) treatment had no significant effect on sucrose levels. The combination of stimulant and PEG also had no significant effect on sucrose levels (Table 3).

Table 3. Mean of sucrose (mM) by Stimulant and PEG Treatment on 6 years old of clone PB 260

Treatment	Sucrose
Stimulant	
S_0 (control)	3.50
S_1 (Formulation N_2O_1)	4.42
S_2 (etephon 1,5%+Formulation N_2O_1)	4.28
S_3 (etephon 2,5%+ Formulation N_2O_1)	3.87
PEG application	
P_0 (control)	3.76
P_1 (PEG 3%)	4.27
Interaction	
S_0P_0	2.90
S_0P_1	4.09
S_1P_0	3.97
S_1P_1	4.86
S_2P_0	4.23
S_2P_1	4.32
S_3P_0	3.94
S_3P_1	3.81

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% and 1% Duncan test. N_20_1 (NAA 100 ppm + Kinetin 50 ppm + Palmitic Acid 2%).

Table 3 shows that stimulant has no significant effect on sucrose level. Likewise, PEG treatment also had no significant effect on sucrose levels. There is an increase in sucrose levels with PEG treatment. Combination of stimulant and PEG had no significant effect on sucrose levels, but there was a tendency to increase in sucrose levels.

Sucrose is raw material for latex and related to the level of exploitation [15]-[14]. Results of sucrose analysis in high metabolic clones such as PB 260 are usually low, whereas on low metabolic clones are usually high. This is becuase in high metabolic clones; sucrose produced from photosynthesis is mostly used for latex biosynthesis. Such finding is consistent with Woelan, et al., (2013) [13] and Jacob, et al., (1989) [16] which states that sufficient availability of sucrose for rubber synthesis is an important factor so that rubber synthesis can occur continuously and rubber plants can produce latex optimally.

Thiol (mM)

Thiol content is associated with an increase in dry tapping groove (KAS) (Woelan, et al., 2013). Results of statistical analysis showed that stimulant (S) treatment had no significant effect on thiol levels. Likewise, PEG (P) treatment also had no significant effect on thiol levels. Combination of stimulant and PEG did not have significant effect on thiol levels (Table 4).

Table 4. Mean of Thiol (mM) by Stimulant and PEG Treatment on 6 years old of clone PB 260

Treatment	Thiol
Stimulant	
S_0 (control)	0.82
S_1 (F-8treormulation N_2O_1)	0.67
S_2 (etephon 1,5%+Formulation N_2O_1)	0.61
S_3 (etephon 2,5%+ Formulation N_2O_1)	0.65
PEG application	
P_0 (control)	0.69
P_1 (PEG 3%)	0.68
Interaction	
S_0P_0	0.82
S_0P_1	0.82
S_1P_0	0.75
S_1P_1	0.59
S_2P_0	0.56
S_2P_1	0.66
S_3P_0	0.65
S_3P_1	0.64

Note: The numbers followed by the same letter on the same row or column are not significantly different at the 5% and 1% Duncan test. N_20_1 (NAA 100 ppm + Kinetin 50 ppm + Palmitic Acid 2%)

Table 4 shows that stimulant; PEG and the combination had no significant effect on thiol levels. There was a decrease in thiol levels but still within normal range where the optimal level of thiol was 0.4-0.9 mM [17]

From perspectives of Thiol levels, the use of stimulants made from bark recover and PEG did not has negative effect on observed parameters. This is because Thiol is a parameter related to antioxidants that reflect plants ability (active oxygen species) to prevent cell damage by free radicals [16]-[18].

According to Sumarmadji (1999) [19], besides as activator for various enzymes, Thiol also able to maintain lutoid membrane stability that is neutralize some toxic oxygen compounds such as H_2O_2, OH and O_2.

Table 4 show that although there was a decrease in Thiol levels due to PEG and combination of stimulant and PEG treatments, but still in safe level for plants. Field observations showed there is no plant experiencing Dry Tapping Grooves

4. Conclusion

Stimulant application has significant effect in increasing the latex production. PEG application has significant effect in encouraging increased latex production (g/p/s) and inorganic phosphate (mM). Combination of stimulant and PEG treatment can increase production of latex (g/p/s) and inorganic phosphate (mM). Physiologically, application of PEG based alternative stimulants is safe for plant health.

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