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Application of Plant Growth Regulator and Oleochemicals to Increase Yield and Accelerate Bark Renewable of Quick Starter PB 260

Murni Sari Rahayu[a*], Luthfi A. M. Siregar[b], Edison Purba[c], Radite Tistama[d]

[a]*Postgraduate Student, Agriculture Sciences, University of North Sumatera, Medan*

[b,c]*Lecturer Staff, Agriculture Sciences, University of North Sumatera, Medan*

[d]*Rubber Research Institute, Sungai Putih, Deli Serdang, North Sumatera*

[a]*Email: murnisarirahayu@ymail.com*

Abstract

The aims of this sudy is to find optimum combination concentration of NAA^{+} and Oleochemicals to accelerate bark recovery of clones PB 260; evaluate the acceleration response of bark recovery on clones PB260 with application of NAA^{+} - Oleochemicals; find out the concentration of ethylene (etephon) and the combination of NAA^{+}-Oleochemicals and PEG concentrations and optimum combinations of NAA^{+}-Oleochemicals to increase rubber yield and accelerate bark recovery. The research design is randomized block design (RAK) with 2 factors, namely NAA concentration (N) and the type of oleochemical (O). Factor of NAA concentrations (N) consisted of four levels, namely: N_0 = without plant growth regulator (control), N_1 = 50 ppm + 50 ppm (cytokines), N_2 = 100 ppm + 50 ppm (cytokines), and N_3 = 150 ppm + 50 ppm (cytokines). Factors of oleochemicals types (O) consisted of four levels namely O_0 = without Oleochemicals (control), O_1 = palmitic acid, O_2 = Oleic Acid, and O_3 = stearic acid. The results showed that the number of latex vessels has significant effect on NAA concentrations, but has not significant effect on bark thickness, TSC and yield. Oleochemicals treatment has significant effect on bark thickness, yield and the number of latex vessels, but not significantly affect the TSC.

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* Corresponding author.

The combination of NAA concentration and oleochemical type has not significant effect on the number of latex vessels, bark thickness, TSC and Latex yield.

Keywords: NAA concentration; Oleochemicals type; bark Recovery.

1. Introduction

Rubber tree (*Hevea brasiliensis*) is one of the important agricultural commodities at international level, especially for Indonesia. Beside as a source of non-oil foreign exchange, rubber is also a source of income for many farmers [1].

Bark is the main capital of rubber farming. By relying on the bark, this tree can be tapped for long period of time and continuously to produce latex. Inappropriate tapping will causing the formation of the recovered bark bump, complicate further tapping and bark quickly exhausted. This imply that bark maintenance is a must in rubber farming, because tapping on good bark and regularly will cause long period of economic life up to 25-35 years, even 50 years or more [2].

In addition, bark recovery is very important for nutrients, water and sugar supply as raw material for rubber formation. According to [3] if the bark recovery goes well and quickly, then the recovered bark can be tapped again after the bark thickness up to 7 mm and it is requires 7-8 years. If the recovery can be accelerated, then tapping on the recovered bark can be done more quickly, thus increasing the latex yield [4].

Due to the reason, acceleration of bark recovery becomes very important and efforts are needed to achieve this goal. Such efforts are qualified tapping, fertilizing, regularly maintenance tapping section and other cultivation techniques. However, efforts or research that directly influences the cambium activity is still limited.

Bark tissue formation is result of secondary meristem activity (cambium). Growth regulator and exogenous oleochemicals is needed to increase the activity of the cambium. The use of growth regulators in rubber tree affects the cambium. This is because the rubber tree is dicotyle that has open xylem and phloem vessels [5].

In addition to the use of growth regulators, the use of oleochemicalis also known able to restore damaged tissue due to presence of diseases. Baeley and Baptist (1939) reported that the application of oleochemicals can promote the growth of recovered bark tissue on the rubber trees by an average of 40% [6]. Oleochemicalsis known as industrial raw materials obtained from vegetable oils, namely palm oil that containing oleic glycerides acid and linol acid (approximately 50%) and glycerides of palnitinacid (25%), steanin acid (3-5%) and liknogliserinacid (0.1%). Compounds contained in this palm oil assumed act as a stimulant for bark recovery [7; 8; 9; 10]. However, research on the benefits of oleochemicals to increase latex yield and bark recovery have not been widely known.

The aims of this research is find out optimum combination of NAA^+ and Oleochemicals concentration to accelerate bark recovery, as well as to study the response of bark recovery on rubber clone PB 260 with application of NAA^+ and Oleochemicals.

2. Material and Method

The research activities was carried out at experimental farm of Rubber Research Institute, Sungai Putih, Regency of DeliSerdang, Province of North Sumatra. The research site located at 25 m above sea level with Ultisol soil type.

Testing on some types of oleochemicals and various NAA concentrations for 6 years old of clone PB 260 was conducted in field and the physiology laboratoryof SungaiPutih Rubber Research Institute.

Materials: The materials used in this study consisted of field and laboratory observations materials. Field materials is including 6 years old of clone PB 260, NAA and some of Oleochemicals (palmitic acid, oleic, linoleic, stearic acid) Sudan III. Materials for physiology laboratory analysis is TCA (Triclavo-asetrasi), sulfuric acid (H_2SO_4 70%), dithiobis nitro benzoic acid (DNIB) and ethanol.

Tools: Meter, TAPSP, light microscope, tapping knives, containers bowls, gutters, buckets, brushes, stationery, black and white paint, an analytical balance / digital, cameras and other supporting tools. Physiology and histology tools are analytical balance, glass beaker, reaction tubes, oven spectrometer Becleman DO 650, mortal and blender. The research design is factorial randomized block design with two factors and three replications. Treatment factors is NAA$^+$cytokinin concentration (N) that consisted of 4 levels namely N_0 = without plant growth regulator (control), N_1 = 50 ppm + 50 ppm (cytokines), N_2 = 100 ppm + 50 ppm (cytokines), and N_3 = 150 ppm + 50 ppm (cytokines). Factors of oleochemicals types (O) consisted of four levels namely O_0 = without Oleochemicals (control), O_1 = palmitic acid, O_2 = Oleic Acid, and O_3 = stearic acid.

3. Results

3.1. Bark Thickness

The analysis results show that the treatment of NAA (N) concentration did not significantly affect the bark thickness while types of oleochemicals (O) have significant effect on bark thickness. Combination of oleochemicals type and NAA concentrations did not significantly affect the bark thickness.

Table1: Bark thickness at Treatment of NAA concentration and oleochemicals type

Treatment	oleochemicals type				Average
	O_0	O_1	O_2	O_3	
NAA concentration					
N_0	0, 97	1, 63	0, 90	1, 40	1, 23
N_1	1, 27	1, 67	1, 50	1, 17	1, 40
N_2	1, 33	1, 94	1, 47	1, 37	1, 53
N_3	0, 73	1, 30	1, 33	1, 90	1, 32
Average	1, 08 d	1, 64 a	1, 30 c	1, 46 b	

Note: Numbers followed by the same letter in the same row or column are not significantly different at Duncan test level of 5% and 1%.

Table 1 show that concentrations of NAA 100 ppm + 50 ppm (N_2) has the highest leaf thickness parameter value namely 1.53, followed by 50 ppm + 50 ppm (N_1), 150 ppm + 50 ppm (N_3) and 0 ppm (N_0). Likewise, the application of oleochemicals type in palmitic acid (O_1) is 1.64, significantly different to stearate (O_3), oleic (O_2) and without oleochemicals (O_0).

3.2. Number of Latex Vessel

The analysis show that both treatment of NAA (N) concentration and oleochemicals types (O) has significant effect on the number of latex vessels. Combination of oleochemical type and NAA concentrations did not significantly affect the number of latex vessels.

Table 2: Number of Latex vessels on Treatment of NAA concentration and Oleochemicals type

Treatment	Oleochemicals type				Average
	O_0	O_1	O_2	O_3	
NAA concentration					
N_0	12, 67	19, 00	15, 67	15, 67	15, 75 d
N_1	17, 67	24, 67	14, 67	21, 67	19, 67 c
N_2	20, 00	24, 33	21, 67	19, 67	21, 42 b
N_3	13, 33	20, 00	17, 67	20, 33	17, 83 a
Average	15, 92 d	22, 00 a	17, 42 c	19, 34 b	

Note: Numbers followed by the same letter in the same row or column are not significantly different at Duncan test level of 5% and 1%.

Table 2 show that NAA concentrations at 100 ppm + 50 ppm (N_2) has the highest number of latex vessels parameter namely 21.42 which is significantly different than 50 ppm+50 ppm (N_1), 150 ppm+50 ppm (N_3) and 0 ppm (N_0).

Likewise, the application of oleochemicals type in palmitic acid (O_1) has the highest number of latex vessels parameter namely 22.00 which significantly different than stearate (O_3), oleic (O_2) and without oleochemicals (O_0).

3.3. Yield

The analysis show that treatment of NAA (N) concentration and the combination NAA (N) concentration + oleochemicals types did not significantly affect the yield, but treatment of oleochemicals types (O) significantly affected the yield.

Table3: Yield at NAA (N) concentration and oleochemicals types treatment

Treatment	oleochemicals types				Average
	O_0	O_1	O_2	O_3	
	NAA concentration				
N_0	46, 84	54, 25	43, 01	46, 87	47, 74
N_1	48, 02	49, 60	48, 18	48, 21	48, 50
N_2	42, 33	49, 72	45, 00	42, 92	44, 99
N_3	42, 62	47, 97	48, 95	50, 18	47, 43
Average	44, 95 d	50, 39 a	46, 29 c	47, 05 b	

Note: Numbers followed by the same letter in the same row or column are not significantly different at Duncan test level of 5% and 1%. Table 3 show that concentrations of NAA at 50 ppm + 50 ppm (N_1) resulting the highest yield parameter namely 48.50, followed by 0 ppm (N_0), 150 ppm + 50 ppm (N_3) and 100 ppm + 50 ppm (N_2). Likewise, treatment of oleochemicals type in palmitic acid (O_1) resulting the highest yield parameter namely 50.39, which significantly different than stearate (O_3), oleic (O_2) and without oleochemicals (O_0).

3.4. TSC

The analysis show that either concentration of NAA (N), types of oleochemicals (O) and the combination did not significantly affect the TSC.

Table4: TSCat NAA (N) concentration and oleochemicals types treatment

Treatment	oleochemicals types				Average
	O_0	O_1	O_2	O_3	
NAA concentration					
N_0	42, 54	45, 59	42, 12	41, 50	42, 94
N_1	43, 49	41, 10	40, 25	44, 84	42, 42
N_2	38, 07	41, 43	39, 42	38, 34	39, 32
N_3	40, 16	43, 53	44, 31	41, 95	42, 49
Average	41, 07	42, 91	41, 53	41, 66	

Note: Numbers followed by the same letter in the same row or column are not significantly different at Duncan test level of 5% and 1%.

Table 4 show that concentrations of NAA at 0 ppm (N_0) resulting the highest TSC parameter namely 42.94, followed by 150 ppm + 50 ppm (N_3), 50 ppm + 50 ppm (N_1) and 100 ppm + 50 ppm (N_2). Likewise, treatment of oleochemicals type in palmitic acid (O_1) resulting the highest yield parameter namely 50.39, which significantly different than stearate (O_3), oleic (O_2) and without oleochemicals (O_0).

4. Discussion

Statistical analysis showed that application of growth regulators and oleochemicals is not significantly affect the increase of bark thickness, but has significant effect on the number of latex vessels. This is due to the hormone application accelerate rapid cell division. Reference [11] reported that the hormone auxin and GA can increase bark thickness, added girth and number of latex vessels. Treatment of oleochemicals type is significantly increasing the bark thickness, the number of latex vessels and yield. This is because oleochemicals (palmitic acid) used in the study supports the differentiation of bark recovered and latex vessels so that the latex vessels increases. This is consistent with [12] which reported the benefits of oleochemicals to accelerate growth of recovered bark on clone PR 300 with dry tapping grooves symptom. The research showed that the average growth of recovered bark after smeared with oleochemicalonce for 2 months is thicker than 3 months. Therefore, latex yield will be increase by increasing of bark thickness and number of latex vessels (laticifer) [12]. In addition, stimulation mechanism of palmitic acid enzyme systems that similar to stearic acid has similar function as plant growth regulators allegedly involved in the photosynthetic reaction in the Calvin cycle. The results of photosynthesis in the form of carbohydrate and sucrose are used to enlarge the vegetative parts of the tree, especially stem cells and as latex precursor, so latex yield increases. This is consistent with the results of [13] where the use of 50 ppm of stearic acid can increase the growth of bean, marigolds, pumpkins and beets by 30-60%. Effect of palmitic acid on rubber tree to increase bark thickness, the number of latex vessels and latex yield can be seen from the metabolic pathways as presented in Figure 1.

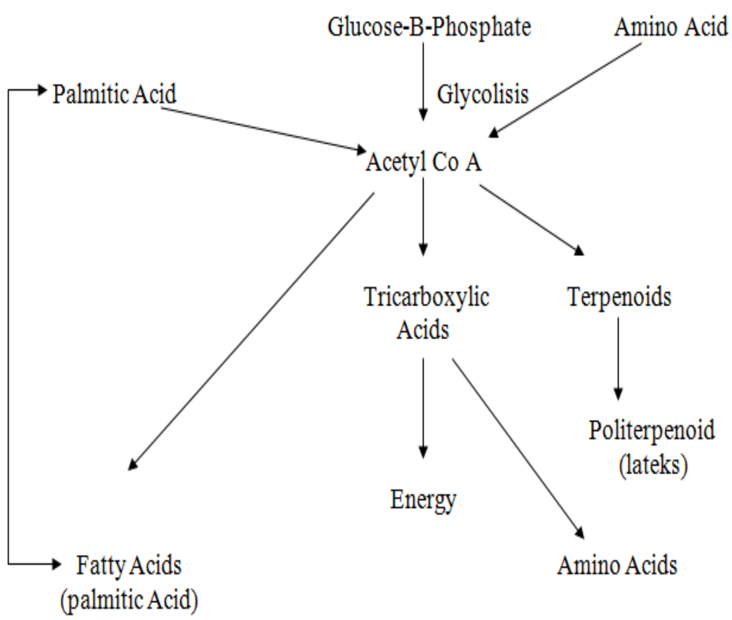

Figure 1: Palmitic Acid Biosynthesis, source [14]

Figure 1 shows that palmitic acid (fatty acid) is one of the base material for Acetyl coenzyme A formation.

Acetyl Co A is an important precursor in the primary and secondary metabolism. In primary metabolism, Acetyl Co A plays in respiration, where Acetyl Co A will be entered into the cycle of Tricarboxylic acid (TCA) for generating energy to be utilized by plants to spur vegetative growth such as enlargement of stem cells (bark thickness and the amount of latex vessels). In the secondary metabolism, Acetyl Co A is precursor to form terpenoids compounds, among other Politerpenoid (latex), so that the application of oleochemicals (fatty acid) can boost the latex yield. In addition to these two metabolic pathways, Acetil Co A can also re-forming fatty acid (oleochemicals) as the base material to form Acetyl Co A [14].

5. Conclusion

1. Application of NAA concentrations is significantly affect the number of latex vessels, but has no significant effect on the bark thickness, latex yield and TSC.
2. Type of Oleochemicals is significantly affect the number of latex vessels, bark thickness and latex yield, but the effect is not significant for the TSC.
3. Interaction of NAA concentration and type of Oleochemicals has no significant effect on the number of latex vessels, bark thickness, TSC, and latex yield.

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