

# Roles Of Growth Regulator To Shorten The Immaturity Period In Some Rubber Clones

Try Koryati, J. A. Napitupulu, Luthfi A. M. Siregar, T. Chairun Nisa

**Abstrak:** The objective of the research was to find out the influence of IAA hormone, kinetin and paclobutrazol which were applied to the clones and which treatment that most likely indicated the response for expediting the girth increment and bark thickness so that the trees can be quickly tapped. The experiment was conducted at Kebun Karang Inong East Aceh. The research was organized, based on Nested Design of three factors, namely a clone factor with 5 levels, hormonal factor of IAA + Kinetin with 7 levels, and paclobutrazol factor with 3 levels. The results showed that the growth regulators applied could accelerate the girth increment and other parameters. Hormone applications significantly influenced the parameters of the girth increment and number of chlorophyll. Although for other parameters the hormone applications did not have a significant effect. The paclobutrazol application treatment through soil ( $P_1$ ) was the best treatment for all the parameters observed. Clone treatment also had a significant effect on the girth increment, leaf area, and number of chlorophyll. The best clone to girth increment was clone PB 330 ( $K_2$ ). Combination of application treatments with paclobutrazol and hormone only significantly affected the girth increment, and the best treatment was  $P_1H_2$ . The combination of all three treatments between clones with paclobutrazol and hormones only significantly affected the number of latex vessels. The largest number of latex vessels was in  $K_2H_3P_1$  treatment.

**Keywords:** rubber clones, TBM, hormones of IAA, kinetin and paclobutrazol.

## 1. Introductions

Based on the data and information in the field, until now the rubber research center is still trying to find ways to speed up tapping mature and acquire high latex production. Plant economic cycles and long plant immature periods (TBM) have actually encouraged different efforts in rubber plant industry to test and modify technologies to obtain a quick return of investment (ROI). To accelerate ROI and improve the productivity of rubber plants, it is necessary to keep improving techniques in culture. If TBM he costs incurred up to the end of PIP may reach 18-19% (Anwar, 2006; Siagian, 2010; Sundiandi, et al., 2009). Efficiency will be even higher if it is based on the present value. These improvements are absolutely necessary in order to maintain investor interest in the rubber and at the same time to enhance the competitiveness of natural rubber producers among rubber-producing countries. Various attempts have been made to shorten PIP such as the use of clones, intensive fertilization, induction of branching, the use of old seedlings, the use of legume to cover crops, routine maintenance and control of white root fungus (Boerhendy and Ampalupy, 2011; Sundiandi et al. 2009). One effort that is expected to be able to accelerate the growth of girth and bark thickness is the use of rubber plant growth regulator (PGR) exogenously so that productive lifespan can be achieved under the age of 4 years. The use of plant growth regulator can affect the cambium, because the rubber plant is a dicotyledonous plant that has open xylem and phloem vessels (Barlow, 1978). The exogenous application of PGR is an alternative to accelerate the girth increment, so that the rubber plant can reach a tapping time period more quickly.

In addition, the use of growth regulators to increase the production of latex should be also accompanied by conducting research on the impact of the application of growth regulators on *Havea brasiliensis* (Nurhamida, et al., 2005). Plant growth regulators are useful to enhance the growth and development of *Havea brasiliensis*. The treatment is given at the beginning of growth with the expectation of increasing differentiation of tissue carriers (Nurhamida, et al., 2005). Latisifer composition consisted of latisifer cells or reed sap contained in the phloem tissue (Fahn, 1991). Furthermore, the potential of rubber production is also dependent on the environment where the plants are growing (agro-climatic zones), management and clones (genetic).

## 2. Materials and Methods

The study was conducted in Kebun Karang Inong PTP-Nusantara I in Nanggroe Aceh Darussalam.. It was located in Alue Genteng Village, Ranto Peurelak District, East Aceh Regency, with a distance of  $\pm 70$  km from the Central Office of Langsa, with an altitude of 51 meters above sea level. The topography is flat to hilly. This research was based on a nested design of three factors, namely clone factor, hormonal factor, and paclobutrazol factor. Clone factor (K) consists of 5 levels, i.e.  $K_1$  = PB clone 260,  $K_2$  = Clone IRR 107,  $K_3$  = Clone PB 340,  $K_4$  = Clone PB 330 and  $K_5$  = Clone IRR 105. Factors of hormones IAA and Kinetin (H), which consisted of 7 levels, i.e.  $H_0$  = Control (without IAA and Kinetin),  $H_1$  = IAA (400 ppm) + Kinetin (50 ppm),  $H_2$  = IAA (400 ppm) + Kinetin (60 ppm),  $H_3$  = IAA (500) + Kinetin (50 ppm),  $H_4$  = IAA (500 ppm) + Kinetin (60 ppm),  $H_5$  = IAA (600 ppm) + Kinetin (50 ppm) and  $H_6$  = IAA (600 ppm) + Kinetin (60 ppm). Paclobutrazol factor (P) consisted of 3 levels, i.e.  $P_0$  = control,  $P_1$  = paclobutrazol application through soil (500 ppm) and  $P_2$  = paclobutrazol application through leaves (500 ppm). The treatment was repeated 2 times, but nested within treatment factors of clone types, so that the number of experimental units was  $7 \times 5 \times 3 \times 2 = 210$  experimental units. Each experimental unit consisted of 4 plants, and the number of plants used was 840 plants. To test each treatment applied was performed by analysis of variance. If the test results indicated a significant effect or a very significant effect, then DMRT test would be carried out.

- Try Koryati worked as a lecturer at the Faculty of Agriculture University Amir Hamzah, Medan, Indonesia.
- J.A.Napitupulu, Luthfi A.M.Siregar and T.Chairun Nisa worked as a lecturer at the Faculty of Agriculture University of Sumatera Utara, Medan 20155. Indonesia
- Try Koryati, Faculty of Agriculture University Amir Hamzah, Medan, Indonesia.  
E-mail: [atikmarno@yahoo.co.id](mailto:atikmarno@yahoo.co.id)

The research implementation was begun by making experimental plots in rubber planting area of 2 years of age which were selected where the clones used were relatively near one another. After the experimental plots were completed in accordance with the treatment to be carried out, initial observations were conducted in each sample from each treatment in accordance with the observations of the response variable. IAA and Kinetin were provided in accordance with the treatment mixed with lanolin (pasta) which was smeared on the bark circle that had been rubbed with sand paper with a width of 2.5 cm around the stem at two positions for each plant. The first position was located at a height of 70 cm above the ground, and the second position was above the first one. The administration interval was once a month for 4 applications. Paclobutrazol was applied in accordance with the treatment, where application through soil was done only one time, and the application through spraying the leaves surface 5 times at an interval of 1 month. The variables observed were as follows: (1) The agronomic characters included girth increment (cm), bark thickness (mm), plant height (m), leaf area (cm<sup>2</sup>), number of

chlorophyll (fruit / mm<sup>2</sup>); and (2) Anatomical characters included the number of latex vessels (fruit) and diameter of latex vessel ( $\pi$ ). The variables observed were as follows: (1) The agronomic characters included girth increment (cm), bark thickness (mm), plant height (m), leaf area (cm<sup>2</sup>), number of chlorophyll (fruit / mm<sup>2</sup>); and (2) Anatomical characters included the number of latex vessels (fruit) and diameter of latex vessel ( $\pi$ ).

### 3. Results and Discussion

#### Effects of Single Factor

The research results of observation 6 BSP (I-III) showed that the clone treatment significantly affected only the girth increment, leaf area and number of chlorophyll. The application of hormones IAA + Kinetin only significantly affected the number of chlorophyll, whereas paclobutrazol application only affected the girth increment and hampered the development of plant height and total chlorophyll (Table 1).

**Table 1.** The Average of the Girth increment, Plant Height, Bark Thickness, the Number of Latex Vessels, Diameter of Latex Vessels, Leaf Area, and the Number of Chlorophylls in 6 BSP (I-III)

Treatment	Increased up to ...6 BSP						
	Girth increment (cm)	Plant Height (m)	Bark Thickness (mm)	Diameter of Latex Vesels ( $\mu$ )	Number of Latex Vessels (fruit)	Leaf Area (cm <sup>2</sup> )	Number of Chlorophylls (fruit/mm <sup>2</sup> )
Clone (K)							
K1= PB 260	6.81 c	1.18	0.94	13.40	1.24	81.46 a	38.01 ab
K2= PB 330	8.42 a	1.34	0.95	13.33	1.43	60.56 c	35.37 c
K3= PB 340	7.03 c	1.31	0.90	12.93	1.34	74.68 ab	37.74 ab
K4= IRR 107	6.88 c	1.27	0.83	13.17	1.15	81.46 a	38.75 a
K5= IRR 105	7.47 b	1.21	0.81	13.58	1.38	68.43 bc	36.64 bc
IAA Hormone +Kinetin							
H0= Kontrol	7.01	1.19	0.77	12.96	1.07	71.57	27.44 d
H1= IAA 400 ppm +Kinetin 50 ppm	7.37	1.15	0.86	13.01	1.30	71.99	35.56 c
H2= IAA 400 ppm +Kinetin 60 ppm	7.42	1.29	0.95	13.03	1.41	79.53	37.63 b
H3 = IAA 500 ppm +Kinetin 50 ppm	7.31	1.23	0.87	13.23	1.45	69.31	38.54 b
H4 = IAA 500 ppm +Kinetin 60 ppm	7.46	1.36	0.91	13.35	1.10	71.30	40.73 a
H5 = IAA 600 ppm +Kinetin 50 ppm	7.05	1.35	0.82	13.36	1.40	75.68	40.82 a
H6 = IAA 600 ppm +Kinetin 60 ppm	7.66	1.26	1.01	14.02	1.43	73.87	40.39 a
Paclobutrazol (P)							
P0 = Kontrol	7.04 b	1.39 a	0.84	13.49	1.23	73.83	32.35 c
P1 = Tanah	7.62 a	1.07 b	0.92	13.19	1.41	71.00	40.73 a
P2 = Daun	7.31 b	1.32 a	0.90	13.17	1.29	75.13	38.82 b

**Note:** Figures followed by the same small letters in column and the same treatment indicate no significant different at 5 % level, based on Duncan Multiple Range Test (DMRT)

As can be seen in Table 1 that each of the clones had different effects on the parameters observed. The clones significantly affected the girth increment, leaf size and the

amount of chlorophyll. However, they showed no significant effect on bark thickness, the number of latex vessels and diameter of latex vessels. During the period of TBM, clone

PB 330 (K<sub>2</sub>) showed the fastest growth, compared with the other clones, to increase girth around 8.42 cm, plant height (1.34 m), bark thickness (0.95 mm) and the number of latex vessels (1.43 fruit) at 6 BSP. This is because clone PB 330 is the recommended commercial clone classified as latex- and timber- producing clones (Aidi-Daslin, Woelan and Suhendry 2009). In addition, each clone has a distinct advantage. Meanwhile, clone IRR 107 (K<sub>4</sub>) showed the largest leaf size and the most chlorophyll content. Treatment of hormones IAA + Kinetin only had a significant effect on the amount of chlorophyll and no significant effect on the parameter of the girth increment, bark thickness, the amount of latex vessels, diameter of latex vessels and leaf size. Although hormone treatment did not show a significant effect on the girth increment, H<sub>6</sub> treatment tended to show the addition of girth increment, bark thickness and diameter of the largest latex vessels compared with other treatments. This is thought to occur because IAA and Kinetin applied were directly absorbed by the stem, so that these hormones could directly affect vascular tissue, as Wilkins (1989) reported that if PGR was given directly to the plants in whole and able to penetrate the surface where they were given, then PGR usually reached the vascular tissues and rapidly distributed with a speed of 50 mm/hour or more. This movement is non-polar, both upwards and downwards in the plant, and hormones usually congregate in areas that have rapid growth and expansion. Cell division in the cambium is known due to auxin and it requires cytokines, because the main function of cytokines is to spur cell division (cytokinesis). There is evidence that the formation of a normal timber which includes cambium division, transversal enlargement of offspring cells, and lignification requires interaction of auxin with cytokinin (Aloni, 1987; 2007; Ugglia et al. 1988; Wilkins, 1989). Paclobutrazol application significantly affected the increase in plant height, girth and the amount of chlorophyll, while the other parameters were not significantly affected by the paclobutrazol application. Furthermore, paclobutrazol application through soil (P<sub>1</sub>) compared to through the leaves (P<sub>2</sub>) during the TBM to 6 BSP was stronger to hamper the plant height, leaf size and increase the girth, bark thickness and the number of latex vessel rings. As previously said, the emphasis of vegetative growth or rubber plant height occurred because of paclobutrazol working mechanism that prevented the production of endogenous gibberellin, lowering the concentration of GA (Sponsel, 1987, Davis, et al, 1988). However, the low concentration did not prevent the formation of new cells, it only inhibited cell elongation. Therefore, this paclobutrazol treatment could reduce stem elongation and consequently plant height. This has a positive effect on the rubber plant, because it can prevent the tree from falling, and the enlargement process of the stem can continue. This is very important to the rubber plant during TBM since the length of being non-productive is very closely related to the size of girth and bark thickness. Although bark thickness was not significantly affected by paclobutrazol, paclobutrazol application through soil tended to show a larger increase. So, paclobutrazol application had a positive effect on the growth of rubber plants during TBM because the greater the girth increment, the more quickly it reached tapping time (productive). The increased girth occurs through the

enlargement of the stem formed by bark tissue (phloem) and the woody tissue (xylem). In general, the results of this research showed that without the application of paclobutrazol (P<sub>0</sub>), the rubber plant growth was higher, causing the girth to increase and bark thickness to decline. While the application of paclobutrazol provided better plant growth, the rubber plant height decreased (inhibited) so that the effect on the stem was the girth and bark thickness became declined. The application through the soil (P<sub>1</sub>) gave the best result, followed by the application through the leaf (P<sub>2</sub>).

### **Effects of Interaction between Clones, Paclobutrazol and Hormones**

The observation result showed that there were different interactions between the parameters observed. The parameters of the girth increment and leaf area had a significant effect on the hormone treatment combination with paclobutrazol in 6 BSP (Table 2). For clone interaction with hormones only had a significant effect on the number of latex vessels and the amount of chlorophyll in 6 BSP (Table 3). Meanwhile, the interaction between clones, paclobutrazol and hormones only had a significant effect on the increase in the number of latex vessels in 6 BSP (Table 4). The research results based on observations up to 6 BSP in Table 2 show that only the parameters of the girth increment and leaf area were significantly affected by a combination of paclobutrazol with hormones, while other parameters were not significantly affected. The role of a combination of hormones and paclobutrazol in girth enlargement process was supported by several previous studies. This is also evident in this study, where paclobutrazol through soil treatment with hormones (P<sub>1</sub>H<sub>2</sub>) created the largest girth around 7.75 cm compared with the other treatment combinations. This was also followed by the increase in bark thickness and the number of latex vessels in the combined treatment of P<sub>1</sub>H<sub>2</sub> although it did not show a significant effect. The effect of the combination was very supportive to the clonal growth of TBM to accelerate the plant to be readily tapped

**Table 2.** The average Girth Increment and Leaf Area Due to Hormone and Paclobutrazol Treatments in 6 BSP

Treatment of Hormones with Paclobutrazol	Girth Increment (cm) up to... 6 BSP		Leaf Area 6 BSP
	6		
	II-III	I-III	
H0P0	3.56 b	5.81 c	61.83 c
H0P1	5.10 a	7.82 a	76.13 abc
H0P2	4.69 a	7.42 ab	76.75 abc
H1P0	4.76 a	7.12 ab	78.36 abc
H1P1	4.96 a	7.58 ab	59.16 c
H1P2	4.86 a	7.40 ab	78.46 abc
H2P0	5.00 a	7.35 ab	78.89 abc
H2P1	4.77 a	7.75 a	81.68 abc
H2P2	4.42 a	7.15 ab	80.02 abc
H3P0	4.32 a	7.01 ab	73.26 abc
H3P1	5.02 a	7.55 ab	72.12 abc
H3P2	4.79 a	7.35 ab	62.55 c
H4P0	4.55 a	7.51 ab	77.29 abc
H4P1	4.81 a	7.64 ab	63.88 bc
H4P2	4.61 a	7.23 ab	72.72 abc
H5P0	4.31 a	6.77 b	62.20 c
H5P1	4.49 a	7.30 ab	74.86 abc
H5P2	4.45 a	7.07 ab	89.97 a
H6P0	4.84 a	7.71 ab	86.99 ab
H6P1	4.70 a	7.72 a	69.18 abc
H6P2	4.70 a	7.56 ab	65.45 bc

**Note:** Figures followed by the same small letters in column and the same treatment indicate no significant different at 5 % level, based on Duncan Multiple Range Test (DMRT)

In this case, there is a role of hormones and paclobutrazol together, either directly or indirectly, to increase girth. However, the environmental factors were also thought to be quite influential due to the pressure of plant height. This occurred because the working mechanism of paclobutrazol inhibited giberellin endogenous production, thus reducing the rate of elongation, but the formation of new cells persist (Sponsel, 1987, Davis, et al, 1988). With reduced plant height, the effect is switched to stem enlargement. Basically, an important goal to be able to manipulate the production of (latex) cannot be separated from efforts to improve the structure of the plant. Thus, the interaction between hormones with paclobutrazol is very important in the rubber plant during TBM, because the length of the non-productive age (TBM) is closely related to the size of girth. The more quickly the girth increment, the faster the plants become productive (TM). Furthermore, Table 3 shows that

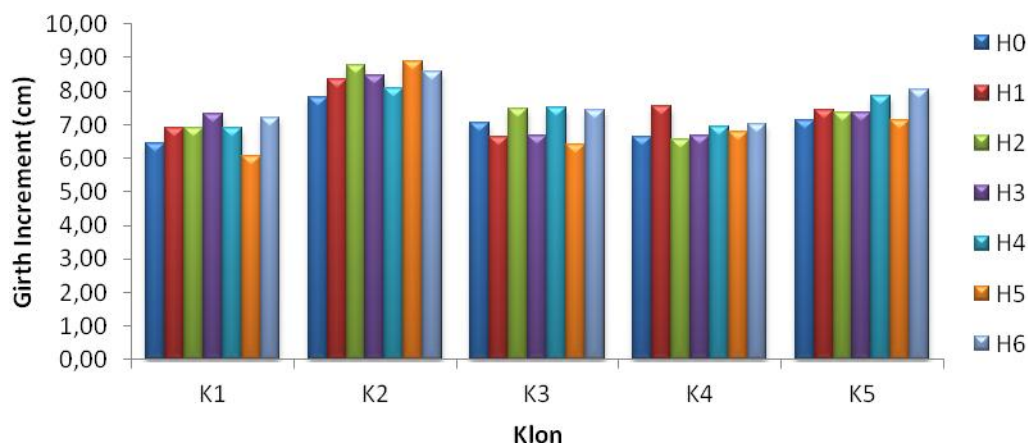
for all the parameters observed only the parameters of the number of latex vessels and the amount of chlorophyll in 6 BSP were significantly affected by a combination of hormone treatment (IAA + Kinetin) with clones. K<sub>2</sub>H<sub>2</sub> treatment showed the largest increase in the number of latex vessels and K<sub>4</sub>H<sub>6</sub> showed the largest amount of chlorophyll. So each clone had different effects on the parameters observed. Although the girth increment parameters showed no significant effect, K<sub>2</sub>H<sub>5</sub> treatment tended to show the greatest girth increment (Fig. 1). It is assumed that the cell division in the cambium is always influenced by auxin which is accompanied by cytokines. Cytokinesis does not promote the growth of its own organs, because cytokinesis is the division process alone. Therefore, the whole growth requires cell division. So the cooperation between cytokinins and auxin was definitely needed (Salisbury and Ross, 1992)

**Table 3.** The Average of Plant Height, Leaf Area in 3 BSP and Number of latex vessels and Number of Chlorophylls Due Clone and Hormone Treatments in 6 BSP

Treatment of Clone with Hormones	3 BSP		6 BSP	
	Plant Height (m)	Leaf Area (cm <sup>2</sup> )	Number of Latex Vessels (fruit)	Number of Chlorophylls (fruit/mm <sup>2</sup> )
K1H0	0.54 c-i	33.67 ij	1.58 a-f	30.20 kl
K1H1	0.58 b-h	28.81 j	1.33 a-f	35.00 f-j
K1H2	0.69 abc	40.93 g-j	0.96 def	40.33 a-e
K1H3	0.80 a	34.02 ij	1.17 b-f	40.58 a-e
K1H4	0.75 ab	36.63 ij	1.50 a-f	42.22 abc
K1H5	0.68 a-d	32.95 ij	1.00 c-f	40.20 a-e

K1H6	0.59 b-g	28.68 j	1.17 b-f	37.53 d-j
K2H0	0.52 c-j	65.28 c-f	1.25 a-f	25.60 m
K2H1	0.63 a-e	81.59 a-d	0.83 ef	35.03 f-j
K2H2	0.48 e-l	89.15 ab	2.17 a	33.33 jk
K2H3	0.61 b-f	103.56 a	2.08 ab	34.60 g-j
K2H4	0.58 b-h	81.13 a-d	0.75 f	42.07 abc
K2H5	0.65 a-e	88.26 ac	1.42 a-f	37.47 d-j
K2H6	0.63 a-e	88.53 ac	1.25 a-f	39.50 a-f
K3H0	0.41 b-l	49.17 f-j	1.00 c-f	27.28 lm
K3H1	0.37 i-l	40.99 g-j	1.92 abc	33.78 ijk
K3H2	0.34 kl	36.32 ij	1.83 a-d	37.97 c-i
K3H3	0.32 l	39.77 bij	1.25 a-f	40.43 a-e
K3H4	0.37 i-l	46.99 f-j	1.25 a-f	40.73 a-e
K3H5	0.43 g-l	34.21 ij	1.50 a-f	42.12 abc
K3H6	0.39 i-l	37.57 ij	1.00 c-f	41.88 a-d
K4H0	0.45 f-l	65.26 c-f	0.92 def	28.00 lm
K4H1	0.39 i-l	83.59 a-d	1.08 c-f	39.98 a-e
K4H2	0.40 i-l	63.41 d-g	1.08 c-f	37.20 e-j
K4H3	0.42 g-l	55.40 e-l	1.25 a-f	38.87 b-g
K4H4	0.42 g-l	62.93 d-h	1.17 b-f	40.23 a-e
K4H5	0.44 f-l	46.40 f-j	1.08 c-f	43.10 ab
K4H6	0.38 i-l	45.74 f-j	1.08 c-f	43.85 a
K5H0	0.51 d-k	93.95 ab	1.25 a-f	26.10 m
K5H1	0.54 c-l	74.59 b-e	1.17 b-f	34.00 b-k
K5H2	0.52 c-j	78.16 b-e	1.00 c-f	39.33 a-f
K5H3	0.44 f-l	91.04 ab	1.75 a-e	38.22 c-i
K5H4	0.35 jkl	82.52 a-d	1.33 a-f	38.42 c-h
K5H5	0.37 i-l	90.37 ab	1.67 a-f	41.23 a-e
K5H6	0.37 i-l	86.39 a-d	1.50 a-f	39.20 c-i

**Note:** Figures followed by the same small letters in column and the same treatment indicate no significant different at 5 % level, based on Duncan Multiple Range Test (DMRT)



**Figure 1.** Histogram Clones Interaction Treatment with Homones to Girth Increment on 6 BSP (III-I)

Table 4 shows that the combination between clones, hormones and paclobutrazol, or the combination of the three up to 6 BSP, only the parameters of the number of latex vessels were significant, while the other parameters did not show a significant effect. From the research, it appeared that each clone had different interactions on the parameters observed. The results showed that the clone

showed the strongest influence on the girth increment, but there was also the influence of hormones and paclobutrazol in determining the increase in girth. As it is known that many biochemical and physiological processes are controlled hormones, although the effect of hormones that initiate the process was not so clear. The highest increase in the number of latex vessels was found in the combined

treatment of  $K_2P_1H_3$  (around 3.50 fruit) compared with the other treatment combinations. Based on the results of this study, it was found that the response of plants to the growth regulator exogenously applied was influenced by the state of the plant endogenous hormones, the growth regulator concentration, plant growth stage and the sensitivity of cells / tissues. Clone responses to the administration of the growth regulators influenced the process and development

as plant hormones affecting the activity of genes that ultimately led to the effect of increasing the plant height, girth, bark thickness, number of latex vessels, leaf size and the amount of chlorophyll. However, the response generated by the rubber plant clones was also influenced plant age, metabolic status, plant development and environmental factors.

**Table 4.** The average Number of Latex Vessel of 6 BSP as a Result of Clone Treatment with Hormones and Paclobutrazol.

Treatments	Increase Number of Latex Vessel (fruit) up to... 6 BSP				
H x P	K1= PB 260	K2= PB 330	K3= PB 340	K4= IRR 107	K5= IRR 5
HOP0	1.00 def	0.75 ef	0.75 ef	0.75 ef	1.00 def
HOP1	1.00 def	2.00 a-f	1.50 b-f	2.00 a-f	1.00 def
HOP2	2.75 abc	1.00 def	1.30 c-f	1.00 def	1.75 b-f
H1P0	0.75 ef	1.00 def	0.75 ef	2.00 a-f	1.50 b-f
H1P1	2.00 a-f	0.50 f	0.75 ef	0.50 f	1.50 b-f
H1P2	1.25 c-f	1.00 def	0.75	1.25 c-f	0.50 f
H2P0	0.88 ef	2.50 a-d	1.00 def	1.00 def	1.00 def
H2P1	1.50 b-f	1.50 b-f	2.00 a-f	2.50 a-d	1.00 def
H2P2	0.50 f	2.50 a-d	1.25 c-f	1.00 def	1.00 def
H3P0	1.0 def	1.50 b-f	1.50 b-f	0.75 ef	2.50 a-d
H3P1	1.50 b-f	3.50 a	0.75 ef	1.00 def	1.25 c-f
H3P2	1.00 def	1.25 c-f	1.50 b-f	1.25 c-f	1.50 b-f
H4P0	1.25 c-f	0.50 f	0.75 ef	0.75 ef	1.25 c-f
H4P1	2.00 a-f	1.00 def	0.50 f	1.00 def	0.75 ef
H4P2	1.25 c-f	0.75 ef	1.75 b-f	1.00 def	2.00 a-f
H5P0	1.0 def	1.00 def	3.00 ab	0.75 ef	2.00 a-f
H5P1	0.50 f	2.00 a-f	2.00 a-f	1.25 c-f	2.25 a-e
H5P2	1.50 b-f	1.00 def	0.75 ef	1.25 c-f	0.75 ef
H6P0	1.50 b-f	2.00 a-f	2.00 a-f	0.75 ef	0.50 f
H6P1	1.00 def	0.75 ef	2.00 a-f	1.00 def	2.00 a-f
H6P2	1.00 def	2.00 a-f	1.50 b-f	1.50 b-f	2.00 a-f

**Note:** Figures followed by the same small letters in column and the same treatment indicate no significant different at 5 % level, based on Duncan Multiple Range Test (DMRT)

**Note:** H= Hormone, P= Paclobutrazol dan K = Clone.

## Conclusion

The results showed that the growth regulators applied could accelerate the girth increment and other parameters. Hormone applications significantly influenced the parameters of the girth increment and number of chlorophyll. Although for other parameters the hormone applications did not have a significant effect,  $H_6$  treatment tended to show the largest girth increment and bark thickness. Paclobutrazol applications had a significant effect on the girth increment, the number of chlorophyll, and hampered the development of plant height and leaf area. The paclobutrazol application treatment through soil ( $P_1$ ) was the best treatment for all the parameters observed. Clone treatment also had a significant effect on the girth increment, leaf area, and number of chlorophyll. The best clone to girth increment was clone PB 330 ( $K_2$ ). Combination of application treatments with paclobutrazol and hormone only significantly affected the girth increment, and the best treatment was  $P_1H_2$ . Meanwhile, the combination of clone treatments with paclobutrazol only significantly influenced the increase in plant height, and leaf area. The combination of all three treatments between

clones with paclobutrazol and hormones only significantly affected the number of latex vessels. The largest number of latex vessels was in  $K_2H_3P_1$  treatment.

## References

- [1] Aidi-Daslin, S. Woelan dan I. Suhendry, 2009. Bahan Tanaman Klon Karet Unggul. Balai Penelitian Sungai Putih, Pusat Penelitian Karet, Medan.
- [2] Aloni.R. 1987. The Induction of Vascular Tissue by Auxin In Peter J. Davies (ed). Plant Hormones and Their Role in Plant Growth and Development. Martinus Nijhoff Publishers, Netherlands. Pp : 363-373
- [3] Aloni.R. 2007. Phytohormonal Mechanisms that Control Wood Quality Formation in Young and Mature Trees. In: *The Compromised Wood Workshop 2007*. K. Entwistle,P. Harris, J Walker (eds). The Wood Technology Research Centre,

University of Centerbury, Christchurch, New Zealand, pp 1-22.

Scots by Positional Growth in Scots Pine by Positional Signaling. *Plant Physiology* 117: 113-121.

- [4] Anwar Chairil. 2006. Manajemen dan Teknologi Budidaya Karet. Pelatihan Tekno Ekonomi Agribisnis Karet di Jakarta, 18 Mei 2006. 24 hal. [http://www.ipard.com/art\\_perkebun/MANAJEMEN%20DAN%20TEKNOLOGI%20BUDIDAYA%20KARET.pdf](http://www.ipard.com/art_perkebun/MANAJEMEN%20DAN%20TEKNOLOGI%20BUDIDAYA%20KARET.pdf)
- [5] Barlow, C. 1978. The Natural Rubber Industry Its Development Technology and Economy in Malaysia, Kuala Lumpur . Oxford University Press, New York. Melbourne. Pp. ; 112-117
- [6] Boerhendhy, I . dan Amypalupy, K. 2011. Optimalisasi Produktivitas Karet melalui Penggunaan Bahan Tanam, Pemeliharaan, Sistem Eksploitasi, dan Peremajaan Tanaman. *Jurnal Litbang Penelitian*, 30 (1): 23-30
- [7] Davis, T.D. ; G.L. Seffens and N. Sankhla. 1988. Triazol Plant Growth Regulator Hort. Rev. 10 : 64-89.
- [8] Fahn, A. 1991. Anatomi Tumbuhan. Terjemahan Ahmad Soedarto Trenggono Koesumaningrat, Machmud Nata Saputra dan Hilda Akmal. Edisi Ketiga. Gajah Mada University Press, Yogyakarta. Hal. 226-245
- [9] Nurhamida, L; Widya Mudiyantini; Marsusi. 2005. Perkecambahan, Pertumbuhan, dan Differensiasi Berkas Pengangkut Tanaman Karet (*Hevea brassiliensis* Muell.Arg) dengan Perlakuan Kombinasi Asam Indol-Asetat dan Asam Giberelat. *Biosmart*, Vol 7. Nomor 2 : 95-99
- [10] Salisbury, F.B. dan C.W. Ross. 1992. *Plant Physiology*. Fourth Edition. Diterjemahkan Oleh Diah R. Lukman dan Sumaryono. *Fisiologi Tumbuhan* Jilid 1 dan 3. ITB Bandung, hal 105-110, 40-50. University Press, Yogyakarta. Hal, 226-245.
- [11] Siagian, N. 2010. Peluang Mempersingkat Masa Belum Menghasilkan pada Tanaman Karet Melalui Penggunaan Bahan Tanam Berbatang Bawah Banyak. *Jurnal Penelitian Karet No.1* , Vol 28
- [12] Sponsel, V.M. 1987. Gibberellin Biosynthesis and Metabolism *In* Peter J. Davies (ed) *Plant Hormones and Their Role in Plant Growth and Development*. Martinus Bihhoff Publisher, Netherland, pp 54-55
- [13] Sudiandi; J.H.Sihombing;N.Siagian dan Karyudi. 2009. Upaya Mempercepat Masa Tanaman Belum Menghasilkan Tanaman Karet di PTP Nusantara III. *Prosiding Lokakarya Nasional Pemuliaan Tanaman Karet*
- [14] Uggla, C., E.J. Mellerowicz, and B. Sundberg. 1998. Indole-3-Acetic Acid Controls Cambial Growth in
- [15] Wilkin, M.B. 1989. *Fisiologi Tanaman* . Terjemahan Mulyani Sutedjo dan A.G.Kartasapoetro. Bina Aksara, Jakarta. Hal. 30-52, 114-130, 199-202.