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Research paper

Relationship between Latex Production and Physiology of Rubber Clone Pb 260

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Abstract

Dominant physiological characteristics of latex in Latex formation are sucrose content, inorganic phosphate, and thiol levels. Relationship between latex physiology character and factors influencing production of latex was examined in 10 years old of clone PB 260. This research aims to study and obtain data on latex physiological characteristics which considered relate to production and find out physiological characters that have significant correlation and direct effect on rubber production. The research site is Sei Putih Farm, PT. Perkebunan Nusantara III is Regency of Deli Serdang, North Sumatra, Indonesia. Clone PB 260 with planting space 2.5 m x 5 m was used as plant material in this study. Every treatment is used 75 trees with girth 65 cm - 70 cm. Based on statistical analysis, in May, June and July, sucrose levels had positive effect on latex production, while Pi and thiol had negative relationship, except in June Pi had a positive effect. In May, latex production is influenced by sucrose, Pi, and thiol by 32.5%, June 27.5% and July 38.5%.

Keywords: *Hevea brasiliensis, clone PB 260, production and physiology latex*

1. Introduction

Clone PB 260 is high metabolic clones with efficient latex regeneration systems and good assimilate distribution so that the potential for production and latex yield is high [1].

Latex production as a quantitative property is controlled by many factors including genetic, physiological and environmental. There is no single recommended model that consistently explaining latex production level. Several research found that there is a relationship between physiological properties with latex production, among others, sucrose levels, inorganic phosphate levels, thiol levels, and pH of latex,[2]–[6].

This research aims to study and obtain data on latex physiological characteristics which considered relate to production and find out physiological characters that have significant correlation and direct effect on rubber production.

2. Material and Methods

2.1. Physiological Parameters

a. Sucrose (mM)

Dehydration of sucrose in concentrated sulfuric acid (70% H2SO4) and heating will give a furfural derivative which reacts with anthrone to carry out a blue reaction which then measured its absorbance at λ 627 nm (nanometer) with Beckman DU 650 spectrophotometer according to Dische's anthrone method [7] .

b. Inorganic phosphate (Pi)

Inorganic phosphate was measured based on the binding principle by ammonium molybdate then reduced by $FeSO_4$ in an acid reaction so that it becomes blue which then the absorbance measured at λ 627 nm (nanometer) with a Beckman DU 650 spectrophotometer according to Taussky and Shorrmethod [8].

c. Thiol (R-SH)

Samples were taken 1.5 ml (or less) and added with TCA 2.5% to total volume 1.5 ml and added with DTNB10mM 75µL. Added with 1.5 ml of Tris buffer 0.5 M and divortex. Let stand at room temperature for 30 minutes. The absorbance is read at λ 421 nm (nanometer) with Beckman DU 650 spectrophotometer or measured from TCA serum based principle reaction with dithiobis-nitrobenzoic acid (DTNB) to form yellow TNB which absorbed at λ 421 nm (nanometer) with Beckman DU 650 spectrophotometer according to McMullen's method [9].

To measure dry production (g/p/s), *Dry weight* is divided by the number of tapped tree and the number of tapping days with the following equation:

$$\text{dry production } (g^{-1}p^{-1}s) = \frac{Dry\ weight\ (g)}{\text{number of tapped tree/number of tapping days}}$$

The measurement of dry rubber content (KKK) is as follows:
Dry weight (g) = Wet weight (g) x Dry Rubber Content (%).

2.2. Data Analysis

Statistical analysis, regression analysis and cross-analysis and Pearson correlation test among variable was done with Minitab ver. 18. Minitab ver. 18.

In the regression analysis, production is used as dependent variable (Y) and latex physiology component is independent variable (X).

The Multiple Regression Model is as follow:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta n Xn + \varepsilon i$$

Where:

Y = dependent variable

β_0 = Intercept
β_i = Regression coefficient associated with X1,…, Xn respectively
X_{ij} = Independent variable predictor j^{th} of i^{th} respondent, also called attribute
E_i = Error (residual) of observation i = 1, 2, 3, ..., n.

3. Results and Discussion

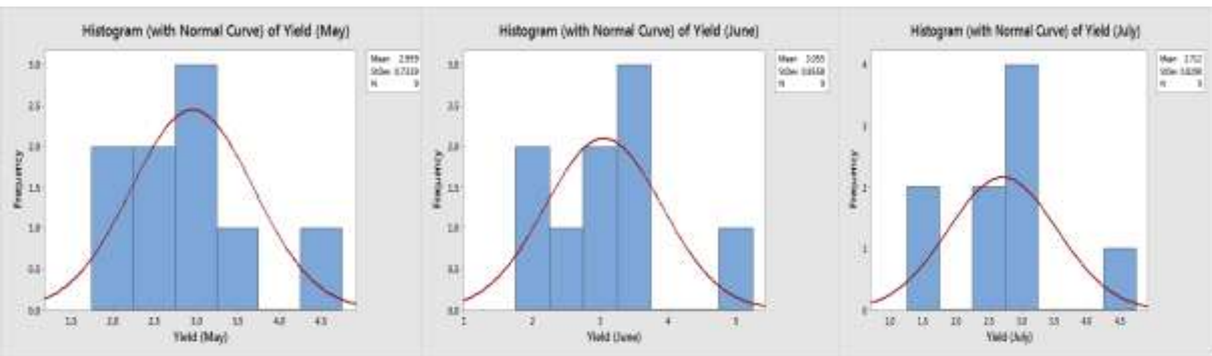
Simple statistical analysis of physiological and latex production observations are summarized in Table 1. Observations for three months (May, June and July) show that physiological characteristics of latex varied among other physiological components, where variance coefficient of Pi level is relatively low, ie 21.78%. This shows variance of Pi level predominantly affects latex production among other latex physiology variables. Clone PB 260 is one of Quick Stater clones. Such clone has high metabolic rate where photosynthate changes in the form of sucrose to latex take place more quickly[10] . Some physiological components of latex, especially Pi levels, have been reported to be related to latex production. Conversion sucrose into latex must be supported by high Pi, where the Pi level is closely related to the level of latex stability in plant tissues. If the Pi level is high, the metabolic process will be carried out quickly, especially those related to latex biosynthesis[2], [11]–[13].

Inside of latex vessel cells, the main form of sucrose is saccharide and this compound is a precursor for latex synthesis[2], [3] .Sufficient availability of sucrose in rubber synthesis is one of the important factors so that rubber synthesis can take place continuously and rubber tree can produce rubber optimally[14], [15]. Variable of sucrose levels observed as long as three months showed a relatively high variance, namely 33.18%, where sucrose has the highest variance than other physiological variables. This is because sucrose level is greatly influences by genetic and environment factors[4] as confirmed by linear multiple regression equations in May as follows : Y = 2.38 + 0.26 Sucrose - 1.63 Thiol - 0.05 Pi. The linear multiple regression equations for Juneis Y = 1.73 + 0.25 Sukrose - 0.24 Thiol + 0.003 P and July is Y = 5.11 + 0.32 Sukrose - 6.58 Thiol - 0.34 Pi (Table 3 and Figure 3). In May, June, and July, Sucrose has positive effect on the latex production that is the higher the sucrose, the more latex production.
For thiol levels, observation for three months showed that the variance is relatively moderate among other latex physiologies, namely 28.47%. Relatively moderate variance meant that the tree is in healthy condition. Thiol act as activators for various enzymes, but also needed for lutoid membrane stability to neutralize several toxic oxygen compounds such as O_2, H_2O_2 and OH. Such Thiol levels is confirming Sumarmadji [3]who found that in February and May thiol levels are generally less than <0.50 mM.

Table 1: Simple statistical summary of physiological analysis and latex production of Clone PB 260

Variable	Sucrose	Pi	Thiol	Rubber Production (g/p/s)
	……………mM……………			
May				
Value				
Minimum	2.84	5.16	0.11	2.20
Maximum	8.77	9.69	0.36	4.48
Means	5.23	6.64	0.27	2.93
Standard Deviation	0.60	0.51	0.03	0.25
KK(%)	33.18	21.78	28.47	24.80
June				
Value				
Minimum	2.84	5.16	0.11	1.94
Maximum	8.77	9.69	0.36	4.48
Means	5.23	6.64	0.27	2.89
Standard Deviation	0.60	0.51	0.03	0.29
KK(%)	33.18	21.78	28.47	28.02
June				
Value				
Minimum	2.84	5.16	0.11	1.94
Maximum	8.77	9.69	0.36	4.48
Means	5.23	6.64	0.27	4.48
Standard Deviation	0.60	0.51	0.03	0.03
KK(%)	33.18	21.78	28.47	28.02

Latex production along May, June and July showed a relatively moderate variance namely 24.80% - 28.02%. The level of variance indicate that in May - June, production is not too low and enough rainfall (Figure 1). In May – June, leaves condition was not fully developed, so the latex production is relatively moderate. Leaf is one factor that influencing latex production, that is as photosynthetic place to produce photosynthate as raw materials for natural rubber biosynthesis [11], [16]



Production in Mei Production in June Production in June

Figure 1: Frequency curve of latex production (g/p/s) on Clone PB 260

When latex production in May, June and July compared (Figure 2), May show high production and July was low. Some research finding show that fruit ripening and leaf growth occurs in January - February, where leaves reach maximum growth and function optimally in March-July [16], [17]. Natural rubber producing countries in Northern Equator have low production pattern in February - April and the highest production achieved in October - December[16], [18]) states that maximum production is usually achieved after the fruit falls, especially in April - May and decline in production occurs in July - January.

Table 2: Correlation coefficient matrix between latex physiology and yield components

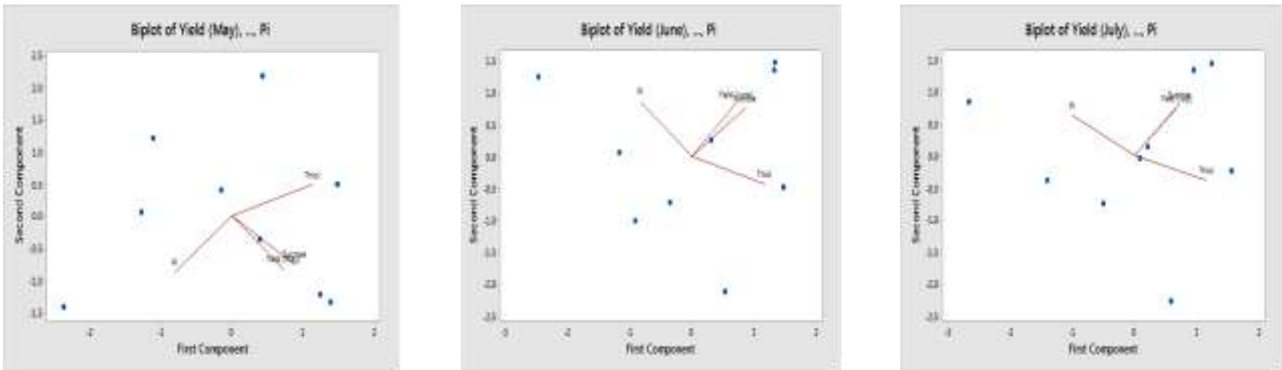
Variable	Production (g/p/s)	Sucrose (mM)	Thiol (mM)
May Sucrose	0.56 tn		
Pi	0.05 tn	0.08 tn	- 0.67*
Thiol	0.11 tn	0.32 tn	
June Sucrose	0.52 tn		
Pi	0.06 tn	0.08 tn	- 0.67*
Thiol	0.15 tn	0.33 tn	
July Sucrose	0.44 tn		
Pi	-0.17 tn	0.08 tn	- 0.67*
Thiol	0.05 tn	0.33 tn	

Results of correlation test among observed variables for three months are presented in Table 2.3 and Figure 3. There is not significant correlation between latex physiology variables with production, indicate that there is relatively low correlation between latex physiological components and latex production. In other words, latex physiology has little contribution to the production of latex [18]. Pi and Thiol has significant negative correlation, means that if the Pi level is high, thiol content is low. According to [3], Thiol act as activators for various enzymes, but also needed for lutoid membrane stability to neutralize several toxic oxygen compounds such as O_2, H_2O_2 and OH. Thiol content is associated with occurrence of Tapping Panel Dryness (KAS). KAS occurs because there is no balance between harvested latex and latex reproduction, so that the tree experiences stress or fatigue and then the lutoid membrane is easily broken and rubber freezes in the latex vessels [2]. Such Thiol levels is confirming [3] who found that in February and May thiol levels are generally less than <0.50 mM

Table 3: Models summary of Latex physiology with latex yield components for three months

Month	Model	R	R Square	Adjusted R Square	Std Error Of the Estimate
May	1	0.761	0.327	0.000	0.000
June	1	0.922	0.275	0.000	0.000
July	1	0.823	0.385	1.630	0.000

The Coefficient of Determination (R^2) for May is 0.327 (Figure 2 and Table 4), means that the relationship between sucrose, Pi and Thiol to latex production (Y) is 32.7%. The Coefficient of Determination (R^2) for is 0.275 and July is 0.385 (Table 3 and Figure 2).



May June July

Figure 2: Hypothetical cross diagram of latex physiological component on production

4. Conclusion

a. From the analysis, it can be concluded that in May, June and July, the levels of sucrose had positive effect on latex production, whereas Pi and thiol had negative effect, except in June Pi had positive effect.
b. In May, June and July, latex production is influenced by sucrose, Pi, and thiol, namely 33%, 28% and 39%, respectively.

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