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Efficiency of double cut alternative tapping system to improve latex productivity of rubber tree clone RRIT251 in marginal area, Thailand

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Abstract

This investigation aims to optimize an appropriate tapping system for rubber production management in northeast area, Thailand. The study was conducted in rubber clone RRIT 251 plantation of farmer located in Khen Dong district, Buriram province during May 2014 to February 2016. The trees were planted in 2007 and the tapping was started in July 2014. The experimental designed was randomized completed block design (RCBD) with 3 replications comprised 2 treatments; conventional tapping system (farmer's method, S/3 d2) as control and double cut alternative tapping system (DCA, 2 x S/3 d2). The results displayed that DCA was able to increase latex yield about 14 % compared to Farmer's method, but DCA decreased the trunk girth increment. Moreover, the percentage of total solid content (TSC) of Farmer's method was significantly higher than DCA. The bark consumption was not significant difference in both tapping. Briefly, DCA had a potential to improve latex productivity in northeast Thailand.

Keywords: DCA tapping system, RRIT 251, total solid content, northeastern Thailand

1. Introduction

Rubber tree, *Hevea brasiliensis*, is well known as a source of essential natural rubber. It is a key product of Thailand. The natural rubber production about 32 percent of the world in 2013 was produced in Thailand [1]. Around 70 percentage of rubber plantations were in southern part. However, according to the policy of the government to reduce poverties and to improve rubber production, rubber trees planted rapidly in dry subhumid area, northeast Thailand where represented about 20 percent of rubber plantations in the country [2].

Tapping system is a technique to improve latex productivity of rubber tree. In Thailand, the farmers generally practiced S/2 or S/3 with 2d/3 or 3d/4. Although, farmers are used those tapping systems to improve the quality of tapping, they were also used high concentration of ethylene stimulation (2-chloroethylphosphonic acid: ethephon) with the tapping frequencies. The function of ethylene, it delays latex vessel plugging and prolongs duration of latex flow [3]. This maybe results to tapping panel dryness (TPD). However, Traoré et al. [4] displayed the optimum increasing of yield should be stimulated by 2.5% of ethylene with 4 times per year. In contrast, yield was reduced when ethylene stimulation was increased the frequency more than this. In case of latex productivity, double cut alternative (DCA) tapping system was proposed which opening two different panels on a tree. Both first and second panel (P-1 and P-2) tap at 75 cm and 150 cm from the ground [5]. Normally, the DCA is mainly

focuses on the optimum tapping frequencies to improve latex yield without stimulation. As the results, it shown that DCA was able to increase latex productivity around 10 percent compared to conventional tapping system [6-8]. Conversely, de Jonge [9] reported that double cut system might affect growth and hence such systems are considered unsuitable for young trees. However, as knew, in the northeastern part, the soil and climate condition were quite differ to traditional area. Hence, the growth and productivity of rubber tree were limited. In term of these constrains conditions, how can latex productivity of rubber tree be increased with double cut alternative tapping system?

However, the previous works paid more on the test of DCA with the famous rubber tree clone RRIM600 [6-8], but there was no the evaluation of DCA on rubber tree clone RRIT251 and also had no work paid on the rubber plantation in the arid area. By Thai's government policy, this clone, RRIT 251, is extended in the new and replanting rubber plantations in Thailand; which, this clone replaced the old rubber clone RRIM600. Therefore, this study is focused on the efficiency of double cut alternative tapping system to improve latex yield, and growth performance of rubber tree clone RRIT251. This investigation aims to optimize an appropriate tapping system for rubber production management in marginal area of northeast area, Thailand.

2. Materials and Methods

2.1 Field site and plant material

This investigation was conducted in rubber tree clone RRIT251 in a farmer plantation located in Khen Dong district, Buriram province. The experiment was carried during May 2014 to February 2016. The rubber trees were planted in 2007 with the spacing 7m x 3m and started tapping on May 2014. The experimental was designed by Randomized Completed Block Design (RCBD) with 3 replications comprised 2 treatments; conventional tapping system (farmer's method) as control and double cut alternative tapping system (DCA). There are 22 trees per plot site (range of girth at 170 cm above ground was 45-47 cm) and the total of number of trees in each tapping system was 66 trees. Both treatments, the rubber trees tapped with one third spiral downward cut and alternate daily tapping (S/3 d2) (Table 1). The farmer's method tapped with single panel started at 120 cm from the ground, whereas DCA tapped by double panels on a tree at 120 cm and 60 cm from the ground for BO-1 and BO-2 (Figure 1).

Table 1 Tapping schedule on farmer's method and double cut alternative (DCA) system

Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Farmer's method (S/3 d2)	T		T		T		T
DCA (S/3 d2)							
BO-2: 60cm			T_{low}				T_{low}
BO-1: 120cm	T_{high}				T_{high}		

T indicates tapping, T-low indicates tapping on low panel (BO-2), and T-high indicates tapping on high panel (BO-1).

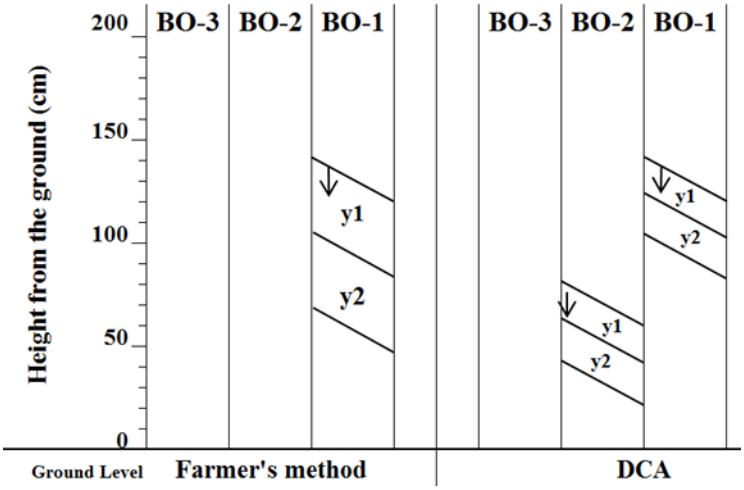

Figure 1 The tapping panel and tapping panel management of tapping systems, y1 and y2 indicated the panel expansion in first and second year. Farmer's method tapped one third spiral down cut (S/3 d2) at 120 cm. DCA tapped two alternated panel at 120 cm (BO-1) and 60 cm (BO-2) with one third spiral down cut (S/3 d2), respectively.

2.2 Data collection

Yield and total solid content was determined by the collected latex volume at each tapping on June, August, and November, 2015. The yield was conducted by fresh latex yield to weighed and calculated to g/tapping/tree. The total solid content (TSC) of each sampled tree was measured during June, August, and November, 2015. Briefly, 5 ml of fresh latex of each sampled tree was collected and weighed. These samples were dried in hot air oven at 70 ºC. After the samples were completely dried, they were reweighed for calculating the percentage of TSC by equation below:

$$\%\text{Total solid content (TSC)} = \frac{Wieght\ of\ dried\ rubber\ (g)}{Weight\ of\ fresh\ rubber\ (g)} \times 100 \quad (1)$$

The trunk girth were measured at 170 cm above the ground. The bark consumption were measured the vertical bark consumption. Both were carried in every month during tapping period and expressed in centimeter (cm).

2.3 Data analysis

The mean of each parameters were subjected to one-way analysis of variance (ANOVA) via least significant difference (LSD) test at the level of $P < 0.05$ using the Statistic version 8 (Analytical Software, Tallahassee, Florida, USA).

3. Results and discussions

3.1 Latex yield

DCA demonstrated of highly significant latex yield (fresh latex) than the farmer's method. The yield of DCA by fresh latex per tapping and yield per tree were increased around 12% in the first year (2014) and 17% in follow year (2015) (Table 2). This result confirmed that DCA can improve the yield same as previous works [6,7,8]. Comparing of yield between first and second years of tapping, the latex yield in second year was lower than the first year in the Farmer's method, while it reversed in the DCA system (Table 2). It might reduce trunk girth increment while the latex productivity was increased [9,10].

The investigation in monthly latex production (Figure 2), the latex yield (g/tapping) was highest production during October to November. This result referred to the highest latex metabolic activity time of rubber tree [10]. Moreover, the comparing between BO-1 and BO-2 panels (Figure 3), it showed that BO-2 displayed higher productivity than BO-1. It indicated that lower panel gave more yield than higher panel. It might refer to the high carbohydrate resources in the wood and bark of rubber tree which are likely to be directly involved in latex regeneration and the basic metabolic for rubber biosynthesis, respectively [11].

Table 2 The yields expressed in fresh latex per tapping and yearly yield (kg/tree).

Treatment	Fresh latex per tapping (g/tree/tapping)				Yearly yield (g/tree)			
	Year 1	%	Year 2	%	Year 1	%	Year 2	%
Farmer's method	101.17a		97.75a		7,992.75a		7,721.88a	
DCA	113.08b	112	114.35b	117	8,933.27b	112	9,033.38b	117
F-test	**		**		**		**	
CV (%)	16.43		15.76		16.43		15.76	

Year 1 tapped from June to December 2014. Year 2 tapped from June to December 2015. Different letters in the same column indicate a significant difference between tapping system at $P < 0.05$. ** indicates significant difference at $P < 0.01$, respectively.

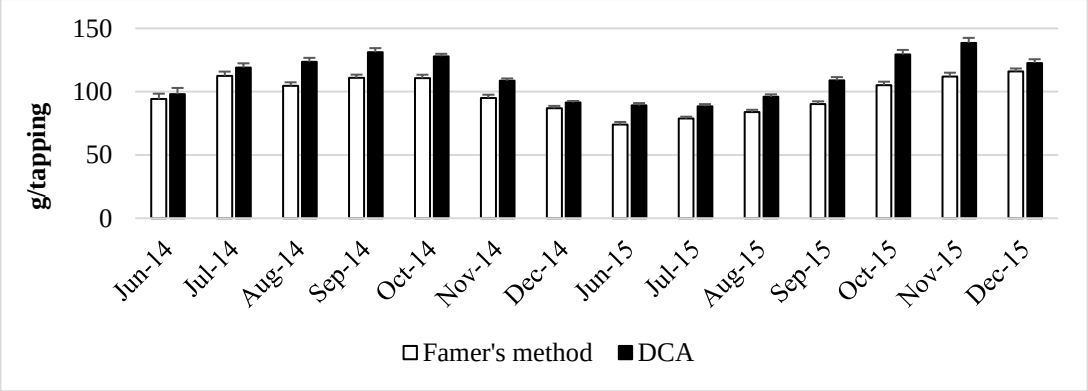

Figure 2 The variation of monthly latex yield (g/tapping) affected by tapping systems on rubber tree in 2 years of tapping. The error bar indicates the standard error.

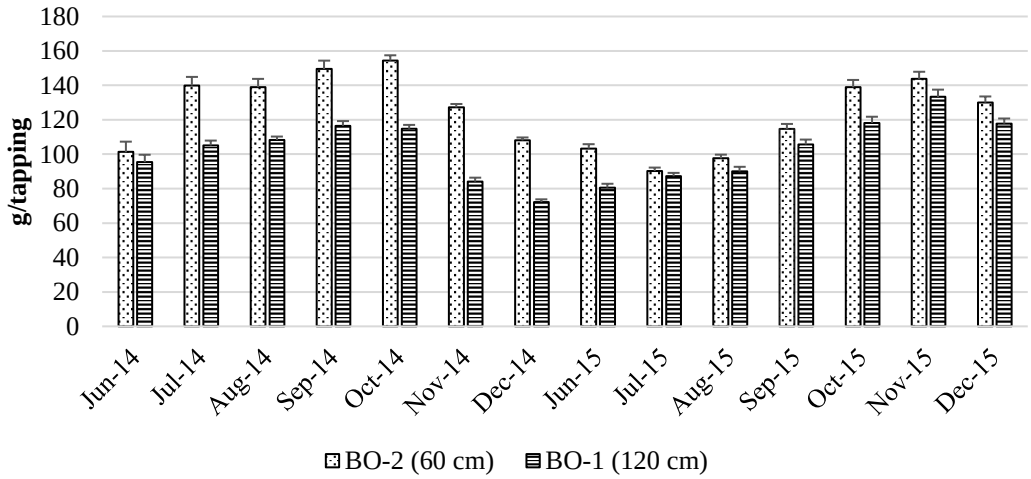

Figure 3 The average of monthly latex production (g/tapping) between BO-1 and BO-2 of DCA. The error bar indicates the standard error, respectively.

Table 3 The average of TSC (%) of both tapping systems during June, August, and November, 2015.

Treatment	June		August		November	
	Average 1	Average 2	Average 1	Average 2	Average 1	Average 2
Farmer's method	46.61	46.61a	43.82	43.82	41.34	41.34a
DCA		44.12b		42.69		36.46b
BO-2 (60cm)	47.59		42.40		36.76	
BO-1 (120cm)	40.65		42.42		36.05	
F-test		**		ns		**
CV (%)		11.58		7.64		7.62

The total solid content (%) of DCA, panel BO-1 and BO-2 was separated. Average 1 is the average of TSC (%) of each panel. Average 2 is the average of TSC (%) of both tapping systems. Different letters in the same column indicate a significant difference between tapping system at $P < 0.05$. ns and ** indicate the non-significant difference and significant difference at $P < 0.01$, respectively.

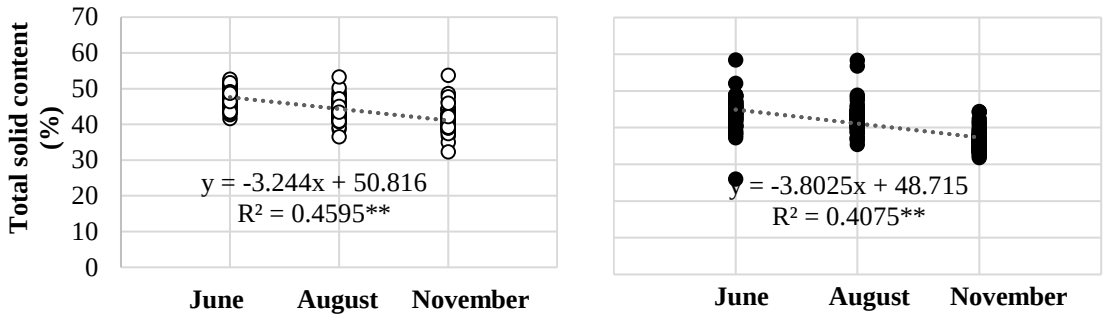

Figure 4 The trend of total solid content during June, August, and November, 2015 (n = 66). The opened circle represents the Farmer's method. The closed circle indicates the DCA, respectively. ** indicate the linear regression analysis at 99%.

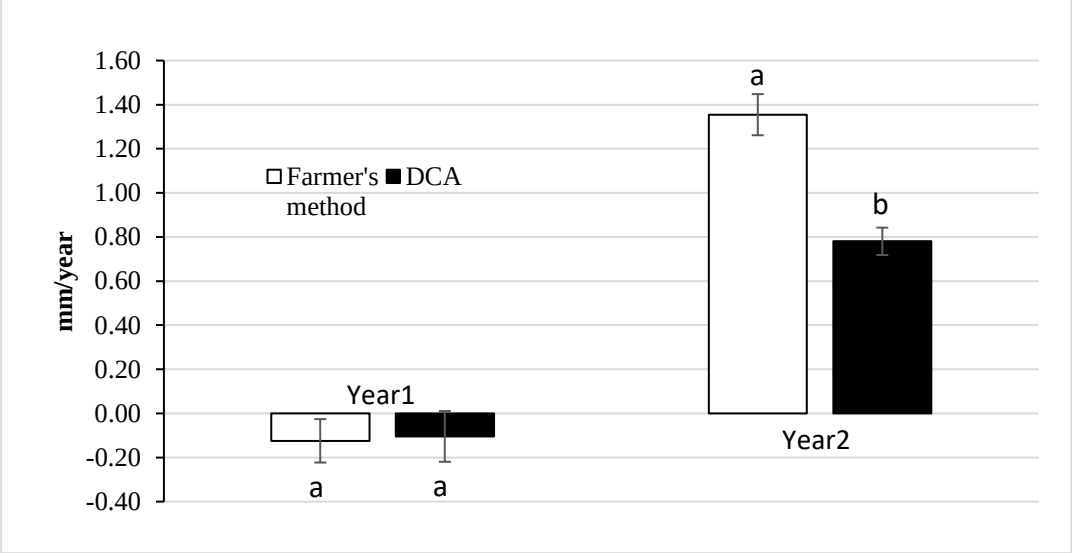

Figure 5 Total trunk girth decrement and increment (mm/year) at 170 cm from the ground divided into Year1 (2014) and Year2 (2015). The vertical bars indicate standard error (n=66). Different letters indicate significant difference among the same year at $P < 0.05$.

Table 4. The average of bark consumption (cm) and total bark consumption of both tapping systems in 2 years of tapping.

Treatment	Year 1 ± SD	Year 2 ± SD	Total
Farmer's method	36.47a ± 1.57	38.04 ± 1.79	74.51
DCA	37.98b ± 1.18	37.44 ± 2.59	75.42
F-test	**	ns	ns
CV (%)	3.73	5.90	3.76

ns and ** indicate the non-significant difference and significant difference at $P < 0.01$. SD means standard deviation, respectively.

3.2 Total solid content-TSC

The TSC of both tapping system was compared in the second year tapping (2015). The result showed that the DCA system gave the percentage of TSC highly significant difference with Farmer's method (Table 3). Additionally, the TSC was highly trend to decrease the percentage according to tapping period (Figure 4). However, this reduction of TSC might make latex flow easy and prolong [12]. Similarly, a recently result of An et al. [13] found that the TSC increased between 20 cm above and 30 cm under the tapping cut.

3.3 Girth increment

The trunk girth at 170 cm from the ground of both tapping systems were reduced in the first year of tapping whereas it increased in the second year. Farmer's method was significantly higher of trunk growth than DCA; while, DCA was higher latex productivity but slightly growth (Figure 5). It might be due to competition between growth and latex regeneration [14]. Chua (1967) reported the high energy absorbing process of rubber formation could lead to depression of growth after tapping [15].

3.4 Bark consumption

The bark consumption, DCA led to higher consume around 1% of vertical bark than farmer system (Table 4). However, there was no significant difference of bark consumption between DCA and Farmer's method.

4. Conclusion

In conclusion, the result showed that DCA had a potential to improve latex productivity in northeast Thailand or marginal area for rubber tree. It was able to increase latex yield about 14 % compared to Farmer's method. Therefore, we can probably contribute implement this tapping system to the rubber farmers in Northeast Thailand. However, long term observation is required to ensure that this tapping system is suitable to the marginal area. Furthermore, the latex diagnosis and some physiological parameter need further investigation to understand the long-term performance of rubber tree response to the DCA tapping system.

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