Evaluation of Low Frequency Tapping Systems with Stimulation on *Hevea* in Traditional Area of Cambodia

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Abstract

In Cambodia, the common tapping system which was widely adopted by smallholders and agro-industry plantations was S/2 d3 for downward tapping and S/4 d3 for upward tapping. However, under the decline of rubber price and increasing labor shortage, the application of low frequency tapping systems (LFT) may be a choice to solve these problems. Hence, different low frequency tapping systems were tested in traditional area of Cambodia. An experiment was established using seven-year old rubber trees of RRIM 600 clone at the Cambodian Rubber Research Station located in Tbong Khmum province. The experimental design was Randomized Complete Block Design with four treatments: T0: S/2 d37d/7 ET 2.5% 4/y, T1: S/2 d4 7d/7 ET 2.5% 5/y, T2: S/2 d5 7d/7 ET 3.3% 6/y and T3: S/2 d6 7d/7 ET 3.3 % 10/y comprising three replications (12 elementary plots). There were 120 trees per treatment in each elementary plot. After 3 years of tapping, LFT system S/2 d6 with Ethephon application (T3) provided the highest dry rubber yield per tree per tapping (g/t/t) but the lowest yield in gram per tree (g/t) and kilogram per hectare (kg/ha). As compared to d3, LFT systems (d4, d5 and d6) caused dry rubber yield loss in kg/ha by respectively 3, 9 and 11% but resulted in increased labor productivity (g/t/t) by respectively 11, 28 and 48%. Therefore, the increase in labor productivity (g/t/t) was higher than the loss in land productivity (kg/ha). Girth increment was not significantly different between treatments. Sucrose and reduced thiol contents of all treatments were not significantly different but inorganic phosphorus content was significantly different depending on the tapping system. Tapping panel dryness was similar for all treatments after three years of tapping.

Keywords: *Hevea*, clone, low frequency tapping, ethephon,

1. Introduction

Up to the end of 2018, the total area of rubber plantation in Cambodia was 436,682 hectares in which 201,949 hectares are under tapping. Some areas are now untapped due to labor shortage. High cost of skilled tappers and tapper shortage are new issues for Cambodia as well as for other natural rubber producing countries. Low frequency tapping systems (LFT) might be the solution to solve these problems (Gohet *et al*., 1991, Soumahin *et al.*, 2009; Kudaligama *et al.*, 2010; Prasanna *et al.*, 2010; Soumahin *et al.*, 2010). LFT system combined with proper ethephon stimulation can maintain the yield as similar as the normal frequency. Ethephon releases ethylene, increasing the duration of latex flow after tapping, by delaying latex coagulation (improvement of

lutoid membranes stability) and by activating latex cell metabolism (Jacob *et al.,* 1989; d'Auzac *et al.,* 1997). Therefore, yield can be significantly improved at each tapping. This leads to a higher labor productivity (kg per tapper and per day) that can compensate the reduction of tapping frequency when using ethylene stimulation (Gohet *et al.,* 1991., Lacote *et al.,* 2010; Njukeng *et al.,* 2011; Traore *et al.,* 2011). The common tapping system for almost all plantations in Cambodia is S/2 d3 7d/7 for downward tapping and S/4 d3 7d/7 for upward tapping. In order to recommend the plantation owners to use LFT system instead, Cambodian Rubber Research Institute (CRRI) has developed research on LFT Systems with stimulation to (i) evaluate the efficiency of LFT systems with ethephon stimulation on yield and labor productivity and their effect on some physiological parameters, (ii) identify the tapping systems showing the best efficiency.

2. Material and Methods

The experiment was carried out at the CRRI research station located in Tbong Khmum province on a level plain set in red basaltic latosols. The climate is governed by the Asian monsoon, which produces two distinct seasons: a rainy season (approximately May to October) and a dry season (approximately November to April).

Clone RRIM 600 was used in the experiment. Rubber trees were planted in 2005 with the spacing of 6m x 3m (555 trees/ha). They were opened at the standard girth of 50 cm and opened at 1.30 m height from the ground. The tapping systems were S/2 d3 7d/7, S/2 d4 7d/7, d5 7d/7 and d6 7d/7.

The experimental design was Randomized Complete Block Design (RCBD) with 4 treatments comprising 3 replications (12 elementary plots). There were 120 trees per treatment in each elementary plot. The experimental treatments are listed in Table 1.

The yield was recorded every tapping day and calculated into g/t, g/t/t and kg/ha. The girth of the trees was measured every year in March at 1.70 m above ground level. Latex diagnosis was performed on a pooled sample of 10 trees in each replication (Jacob *et al.,* 1989). The latex biochemical parameters including total solid content (TSC %), sucrose content (Suc, mM l^{-1}), inorganic phosphorus content (Pi, mM l^{-1}) and reduced thiol content (RSH, mM l^{-1}) were evaluated according to the method developed by CIRAD adapted in 1995 by IRRDB (Jacob *et al.,* 1988; IRRDB 1995). Tapping panel dryness was evaluated by counting once a year the trees showing total bark dryness in each replication of the treatments. It was expressed as percentage in each treatment (Van de Sype, 1984). Statistical analysis of all data was performed by using SPSS software.

Table 1. Details of the experimental treatment

Treatments	Length of cut	Frequency of tapping	Stimulation (year 1-3)
T0	S/2	d3 7d/7	ET 2.5% Pa1(1) 4/y
T1	S/2	d4 7d/7	ET 2.5% Pa1(1) 5/y
T2	S/2	d5 7d/7	ET 3.3% Pa1(1) 6/y
T3	S/2	d6 7d/7	ET 3.3% Pa1(1) 10/y

3. Results

Dry rubber yield

The average yields after 3 years of tapping were significantly different among the four treatments (Table 2). The highest dry rubber yield per tree per tapping (g/t/t) was found with T3 (S/2 d6 7d/7 ET 3.3% Pa1(1) 10/y) reaching 48% more than T0 (S/2 d3 7d/7 ET 2.5% Pa1(1) 4/y) which showed the lowest g/t/t among the 4 treatments. As compared to d3, LFT system (d4 and d5) increased g/t/t by respectively 11 and 28%.

The highest dry rubber yield in gram per tree per year (g/t) was obtained by T0 followed by T1, T2 and T3. This can be related to the higher number of tapping per year. The lowest yield in g/t was found with LFT system d6 (T3).

Dry rubber yield kilogram per hectare per year (kg/ha) also showed significant differences between treatments. T0 (d3) gave the highest yield in kg/ha (1716 kg/ha/y), higher than LFT system (d4, d5 and d6) by respectively 3, 9 and 11%. However, there was no significant difference between T0 (S/2 d3) and T1 (S/2 d4).

Table 2: Yearly average dry rubber yield (g/t, g/t/t and kg/ha) among the 4 treatment over 3 years tapping.

Treatments	**g/t**	**%**	**g/t/t**	**%**	**kg/ha**	**%**
T0: S/2 d3 7d/7 ET 2.5% Pa1(1) 4/y	3794a	100	43.71d	100	1716a	100
T1: S/2 d4 7d/7 ET 2.5% Pa1(1) 5/y	3581b	94	48.57c	111	1662a	97
T2: S/2 d5 7d/7 ET 3.3% Pa1(1) 6/y	3443bc	91	56.01b	128	1560b	91
T3: S/2 d6 7d/7 ET 3.3% Pa1(1) 10/y	3368.c	89	64.68a	148	1520b	89
P value	0.001		0.000		0.000	

Note: Values with different letters in the same column indicate significant difference ($p<0.05$)

Latex biochemistry

Table 3 presents the averages of sucrose content (Suc, $mM.l^{-1}$), inorganic phosphorus content (Pi, $mM.l^{-1}$) and reduced thiols content (RSH, $mM.l^{-1}$) after three years of tapping. Sucrose and reduced thiol contents of all treatments were not significantly different but inorganic phosphorus content was significantly different depending on the tapping system. With lower Pi levels, T2 (S/2 d5) and T3 (S/2 d6) showed less active latex metabolism than T0 (S/2 d3) and T1 (S/2 d4), in conformity with the recorded productions expressed in g/t/y

Table 3. Average of Sucrose, inorganic phosphorus and reduced thiol content in the third year of tapping

Treatments	**Suc (mM.l^{-1})**	**Pi (mM.l^{-1})**	**RSH (mM.l^{-1})**
T0: S/2 d3 7d/7 ET 2.5% 4/y	5.50	18.74 a	0.21
T1: S/2 d4 7d/7 ET 2.5% 5/y	6.83	17.75 a	0.20
T2: S/2 d5 7d/7 ET 3.3% 6/y	5.51	13.66 b	0.23
T3: S/2 d6 7d/7 ET 3.3% 10/y	5.19	15.27 ab	0.22
P- value	0.217	0.031	0.520

Note: Values with different letters in the same column indicate significant difference ($p<0.05$)

Girth and girth increment

Average girth increment after three years of tapping is showed in Figure 1. There is no significant difference between treatments.

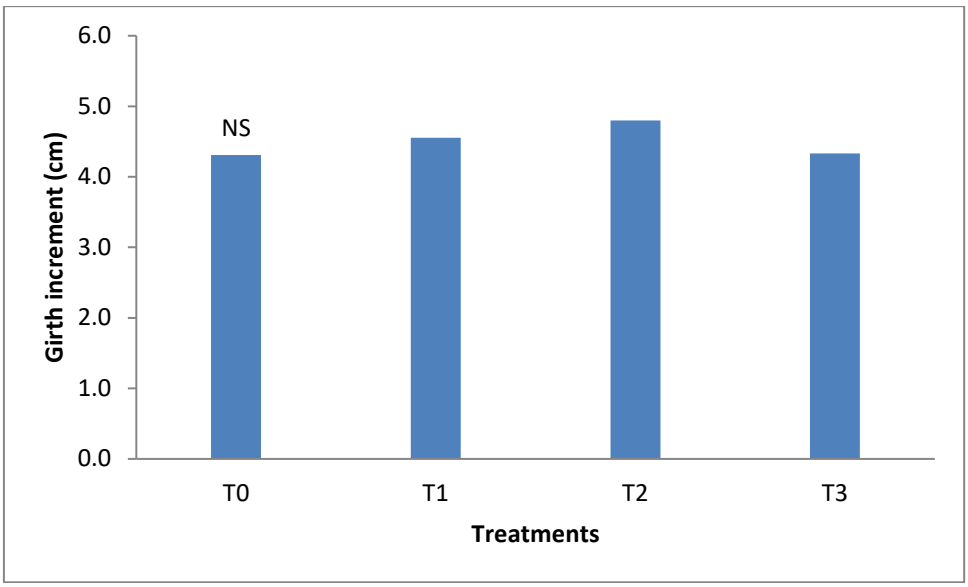

Figure 1: Average of girth increment (cm) after three years of tapping

Tapping panel dryness (TPD)

The incidence of tapping panel dryness was quite similar in all treatments and varied from 3 to 5%.

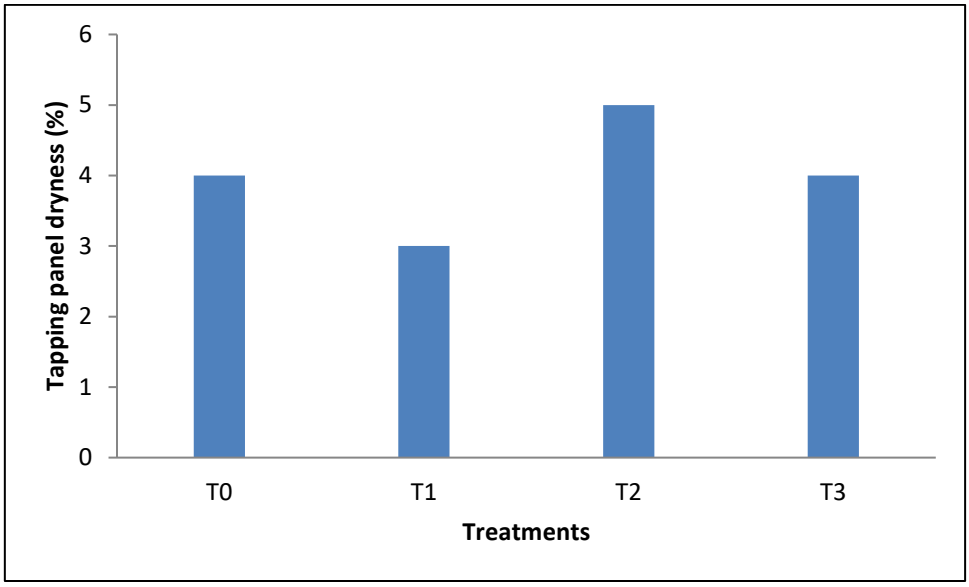

Figure 2: Tapping panel dryness (%) after three years of tapping

4. Discussion

Due to global changes induced by volatility of rubber prices, regular increase of agricultural salaries and probable increasing shortage of skilled tappers, the need to implement reduced tapping frequencies may be more and more important in the future. Reduction of tapping frequency will require compensation by hormonal ethylene stimulation (ethephon, ethylene) (Gohet *et al*., 1991, 1996, 2003, Lacote *et al*., 2010), whose response is itself dependent on an increased latex sugar loading for latex regeneration (Gohet *et al*., 1996, 2003, Lacote *et al*., 2010). Dry rubber yield per tree per tapping (g/t/t) of LFT systems with ethephon stimulation was significantly higher than that of S/2 d3 tapping system (T0) which is widely used in Cambodia. LFT system combining reduction of tapping frequency with ethephon stimulation increase the duration of latex flow after tapping, with the reduction of latex coagulation and the activation of the latex cell metabolism (Jacob *et al.*, 1989; d'Auzac *et al.*, 1997). Therefore, more latex is collected at each tapping. Moreover, it was confirmed possible to compensate the reduction of tapping frequency when using ethephon stimulation. LFT systems (S/2 d4, S/2 d5 and S/2 d6) caused dry rubber yield loss in gram per tree per year and kilogram per hectare per year as compared to d3 tapping system, but this loss was not significant for S/2 d4. This was clearly related to the number of tapping per year. In our local condition, the reduction of tapping frequency with suitable stimulation could compensate the cumulative yield per tree with higher yield per tapping. These results confirmed previous works (Gohet *et al.*, 1991, Rodrigo *et al.*, 2011, Njukeng and Gobina, 2007), mentioning that low frequency tapping systems must be combined with proper stimulant to increase potential yield (g/t/t) at each tapping.

The latex biochemistry consists of inorganic phosphorus content (Pi), reduced thiol content (RSH) and sucrose content (Suc). Sucrose and reduced thiol contents of all treatments were not significantly different but inorganic phosphorus content was significantly different depending on the tapping system. The effect of stimulation is well known by the use of RSH as scavengers to protect the stability of the membranes

of the vacuo-lysosomal system in the latex cells (Jacob *et al.,* 1989; d'Auzac *et al.,* 1997). The differences in Sucrose and RSH contents were not different among treatments. Pi levels were lower for S/2 d5 and S/2 d6, confirming a lower metabolic activity and a lower production expressed in g/t. Although not significantly different, lower levels of Suc observed in those 2 systems S/2 d5 and S/2 d6 could be related to this lower metabolic activity, probably limiting the active importation of Suc into the latex. It could be related as well to the increase in g/t/t. As a matter of fact, an increase in g/t/t increases the need for Suc importation after each tapping (Jacob *et al*., 1989, Gohet *et al*., 1996, Lacote *et al*., 2010) to sustain latex regeneration. Girth increment measurement did not show any difference between treatments. Nugawela *et al.* (2000) found that low frequency tapping system with stimulation did not show negative effect on the growth of rubber trees. In our experiment, combining low frequency tapping with higher ethephon stimulation increased significantly the yield at each tapping while not significantly reducing the growth of the trees. The rate of tapping panel dryness (TPD) was found similar for all treatments, while Obouayeba *et al.* (2009) reported that the rate of TPD was related to the intensity of tapping.

5. Conclusion

After the first three 3 years of tapping, LFT system S/2 d6 with ethephon application (T3) provided the highest dry rubber yield per tree per tapping (g/t/t) but the lowest yield in gram per tree (g/t) and kilogram per hectare (kg/ha). As compared to d3, LFT systems (S/2 d4, S/2 d5 and S/2 d6) caused dry rubber yield loss in kg/ha by respectively 3, 9 and 11% but resulted in increased labor productivity (g/t/t) by respectively 11, 28 and 48%. Therefore, the increase in labor productivity (g/t/t) was much higher than the loss in land productivity (kg/ha). Girth increment was not significantly different between treatments. Sucrose and reduced thiol contents of all treatments were not significantly different but inorganic phosphorus content was significantly different depending on the tapping system. Tapping panel dryness was similar for all treatments after three years of tapping. The results highlight that, in the traditional rubber growing zone of Cambodia, it is possible to use ethephon stimulation to increase the potential yield of the trees at each tapping (g/t/t). Therefore, LFT systems can be applied with proper stimulation to sustain the yield when reducing the tapping frequency.

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