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Performances of low frequency rubber tapping system with rainguard in high rainfall area in Myanmar

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Abstract

In Myanmar, natural rubber (*Hevea brasiliensis*) is mainly grown in the southern part of the country, where the rainfall is too high leading to suspension of tapping in the rainy season and intensive tapping after the rainy season. Rubber farmers face problems of uneven distribution of tapping days, low tapper productivity, high tapping cost, and shorter economical lifespan of the trees. Hence, a study was carried out to address the problems by conducting an on-farm experiment to assess performances of low frequency rubber tapping system (LFRTS) with rainguard in the area. Five treatments: (T_1) S/2 d2 (no tapping in the rainy season); (T_2) S/2 2d3 (no tapping in the rainy season); (T_3) S/2 (RG) d2 (tapping with rainguard in the rainy season); (T_4) S/2 d3 ET2.5% Pa (1) 3/y (m) (tapping without rainguard in the rainy season); (T_5) S/2 (RG) d3 ET2.5% Pa (1) 3/y (m) (tapping with rainguard in the rainy season) were evaluated. The cumulative yield in kilogram per tree of T_5 during the study period was comparable to that of T_1, while its daily yield in gram per tapping per tree was 23% and 30% higher than that of T_1 and T_2, respectively. Bark consumption of T_5 was 16% and 39% lower than that of T_1 and T_2, respectively. T_5 needed only 67% of tapper requirement by d2 frequency tapping. Tapping costs of T_5 were 17% lower than those of conventional tapping system, T_1. The study suggested that LFRTS with rainguard could be implemented to address the problems of the farmers in the area.

Keywords: bark consumption; low frequency rubber tapping system; rainguard; tapping cost; tapper productivity; tapper requirement.
Abbreviations: 2d3_ two tappings in three days; BO-2_ virgin bark at second basal panel; d2_ alternate tapping; d3_third daily tapping; ET_ethephon stimulation; LFRTS_ low frequency rubber tapping system; Pa_ panel application; RG_rainguard; S/2_ half spiral cut (length of tapping cut)

Introduction

Myanmar is one of natural rubber producing countries which contributed 1.6 percent of the world rubber production in 2015. In Myanmar, rubber is traditionally planted in the southern part of the country. Majority of the planted area is owned by smallholders who mainly depend on rubber growing for their livelihoods as their main income. Although the area is the major rubber growing area in the country, there are many obstacles including low productivity which was only 770 kg/ha/yr in 2014 as a major weakness (Myint, 2015). One reason of the low productivity is limitation of the number of tapping days. Normally, in that area, tapping is suspended completely in three and half to four months in the rainy season due to heavy and continuous raining with 4,500 mm of average annual rainfall which starts from June to September. Therefore, around 100-120 working days of tapping are lost during the rainy season without any production from the rubber farms (Zaw, 2012). Consequently, the farmers harvest intensively after the rainy season, from October to May without resting in wintering period although the normal inherent yield is very low in this period. Suspending the tapping in the rainy season causes problems of unevenly distributed tapping days and lack of work for tappers in the rainy season. This leads to shortage of skilled tappers. The practice of high frequency tapping after the rainy season makes lower tapper productivity, higher tapping cost, higher bark consumption and shorter economical life span of the trees.

Since tapping with rainguard in the rainy season increases the number of tapping days by preventing panel wetting and washout (Gan et al., 1985), tapping days can be distributed more evenly. The use of rainguard reduces the problem of seasonal unemployment of rubber tappers (Tillekeratne and Nugawela, 1995) as tapping works can be carried out regularly in the rainy season. During the wintering period, when the yield is too low, tapping should be stopped (Webster and Paardekooper, 1989).

By implementing low frequency rubber tapping systems (LFRTS), rubber yield per tapping per tree could be maximized as it increases the number of days between two successive tappings, notably latex regeneration period, ensure that more latex is regenerated during the period (Serres et al., 1994; Obouayeba et al., 2010; Karunaichamy et al., 2012). However, reduction in tapping frequency reduces cumulative yield per tree. Thus, under LFRTS, yield stimulant must be applied to receive optimum production (Sivakumaran, 1982; Rodrigo et al., 2011). The main effect of stimulation is that of prolonging the duration of latex flow and thus increasing the amount of latex discharged during tapping (Jacob et al., 1989;

d'Auzac et al., 1997). Implementing LFRTS increases the tapper productivity, which is mainly influenced by increased tapping days with every daily yield in gram per tapping per tree, is an important consideration of rubber farmers to reduce the cost of production under current situation of high labour wages (Vijayakumar et al., 2001). It enables to reduce tapper requirement and addresses the problems of skilled labour shortage (Chan et al., 1983; Hassan et al., 1999; Soumahin et al., 2010), without reduction in level of yield, compared to that of the conventional tapping system. In addition, longer economic lifespan of the tree could be expected under LFRTS because of its lower bark consumption (Vijayakumar et al., 2003; Rodrigo, 2012).

Since the suspension of tapping in the rainy season is the main root of the cause of low productivity, implementing LFRTS with rainguard was assumed to be a solution to address the problems. Therefore, a study was carried out by conducting an on-farm experiment on different tapping systems including LFRTS with rainguard, and interviewing the farmers and tappers in the area.

The objectives of the study were to study the effectiveness of rainguard and yield performances, labour requirement and tapping cost of LFRTS with rainguard in the high rainfall area.

Results and Discussion

Rainfall distribution and tapping days

The rainy season started from the middle of May and ended in September in the study area in 2015. Total rainfall was 4028 mm and the total number of raining days was 125 days during the study period from June 2015 to May 2016. Of the total rainfall, 96% was recorded during the rainy season. It peaked in July and August with 1521 mm and 973 mm, respectively (Fig 1).

Figure 2 shows aggregated rainfall during the study period according to three-hourly time patterns. It was found that rainfall peaked in the morning as 36% of the total rainfall was aggregated between 3:00 am and 9:00 AM when the tapping works are normally carried out. Thus, it is confirmed that the rain really interfere the tapping work. Hence, tapping could not be carried out regularly during the rainy season in the area.

Table 1 shows actual tapping days during the rainy season against targeted tapping days according to the different tapping frequencies. Comparing only T_3, T_4, and T_5, which were tapped in the rainy season, number of tapping days of T_4 was the lowest, only 22 days. It was found that around 40 and 30 actual tapping days could be extended by rainguard under d2 and d3 tapping systems, respectively, during the rainy season. T_5 could tap 74% of targeted tapping days effectively while T_3 could meet only 67% of targeted tapping days despite it had more actual tapping days. It shows that under rainguard tapping, d3 frequency tapping is more efficient than d2 frequency tapping in terms of tapping days during the rainy season. Yogaratnam (2013) reported that rainguard is necessary to implement an effective LFRT system in India where the annual rainfall is around 4500 mm and around 140 tapping days are lost each year due to the heavy rain. Sivakumaram et al. (1998) also reported that in Malaysia, rainguard is essential at tapping works as over 70 tapping days and around 500 kg/ha/yr of yield were lost every year due to the rain. As Said et al. (1998) reported, it is found that yield stimulation is more effective under rainguard tapping because tapping panel is dry underneath the rainguard and the yield stimulant could not be washed out by rain.

Rubber yield performance

During the study period, T_2 and T_3 had the highest cumulative yield in kilogram per tree (kg/t) with higher number of tapping days among the treatments (Table 2). It proves that the cumulative yield is directly associated to the number of tapping days. The high number of tapping days of T_3 was contributed by the rainguard tapping in the rainy season while that of T_2 was due to intensive tapping after the rainy season which resulted in the lowest daily yield in gram per tapping per tree. On the other hand, T_5 showed its daily yield in gram per tapping per tree (g/t/t), was 23% and 30% higher than that of T_1 and T_2. It was contributed by LFRTS with yield stimulation which causes higher yield per tapping. However, the cumulative yield of T_5 was not the highest but comparable to that of T_1, S/2 d2 tapping system. These results confirmed that tapping frequency is negatively correlated to the yield per tapping per tree and positively related to cumulative yield (Obouayeba et al., 2011; Lacote et al., 2014). Thanh et al. (1996) reported that cumulative yield of d3 was only 93% of that obtained from d2 tapping system. However, the rainguard tapping allowed higher number of tapping days resulting in comparable cumulative yield. The result found that using proper yield stimulation with effective rainguard could compensate for the reduction in the cumulative yield due to the higher daily yield of LFRTS.

Bark consumption

Table 3 shows comparison of bark consumptions among the treatments during the study period. It was apparent that the average bark consumption of 2d3 frequency tapping, T_2, was the highest with 23% higher than that of d2 frequency tapping, T_1. However, the average bark consumptions of d3 frequency tapping, T_4 and T_5, were lower than that of T_1 (57 % and 62%, respectively). T_2 and T_3 had higher bark consumption (123% and 110% respectively) than that of T_1. It shows that the higher frequency of tapping causes the higher in bark consumption. It is also found in the result that although LFRTS, T_4 and T_5, consumed the thicker bark shaving per tapping than the other treatments, the total bark consumption of T_4 and T_5 during the study period were apparently lower. It replicates the finding by Rodrigo (2012) that although bark shaving per tapping of LFRTS is thicker than that of the conventional tapping, S/2 d2, the effect is marginal compared to overall bark saving. Vijayakuma et al. (2003) reported his finding in India that LFRTS could extend at least four to eight years in the productive lifespan comparing with the conventional tapping system, S/2 d2. Besides, lower bark consumption causes delaying commencement of tapping on renewed barks resulting longer resting period for the renewed bark generation (Kudaligama et al., 2010). Hence, potential higher yield could be expected from the renewed bark under LFRTS (Vijayakumar et al., 2003; Rodrigo et al., 2012).

Tapper requirement

T_1 and T_3 split the trees into two plots and tapped only one plot a day. T_2 separated its trees into three plots and tapped two plots a day. However, T_4 and T_5 split the trees into three plots and tapped only one plot a day. Table 4 shows the requirement of tapper of for 4000 trees of rubber field based on 700 trees of task size.

Table 1. Tappable days in the five treatments in the rainy season (June to September 2015).

Months	No. of raining days	T_1		T_2		T_3		T_4		T_5	
		ATD	TTD	ATD	TTD	ATD	TTD	ATD	TTD	ATD	TTD
JUN	17	0	0	0	0	7	10	5	7	5	7
JUL	29	0	0	0	0	5	16	4	11	4	11
AUG	29	0	0	0	0	11	16	5	11	9	11
SEP	24	0	0	0	0	15	15	8	10	11	10
Total days	99	0	0	0	0	38	57	22	39	29	39
Tappable days (%)		0		0		67%		56%		74%	

ATD = Actual Tapping Days; TTD = Targeted Tapping Days

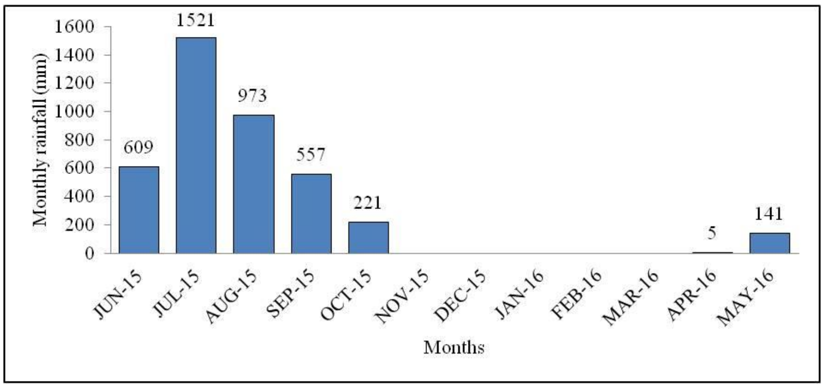

Fig 1. Monthly rainfall from June 2015 to May 2016 at the experiment plot.

Table 2. Daily yield and cumulative yield in the five treatments from June 2015 to May 2016.

Treatment	Daily yield (g/t/t)	Cumulative yield per tree (kg/t)	Number of tapping days
T_1	20.81 d	2.39 b	114
T_2	19.67 e	2.85 a	146
T_3	22.11 c	2.96 a	134
T_4	23.24 b	2.09 c	85
T_5	25.64 a	2.4 b	93
CV	2.48	2.85	

Means with different letter in the same column are significantly different at $p\leq0.05$, computed by Duncan's multiple range Test.

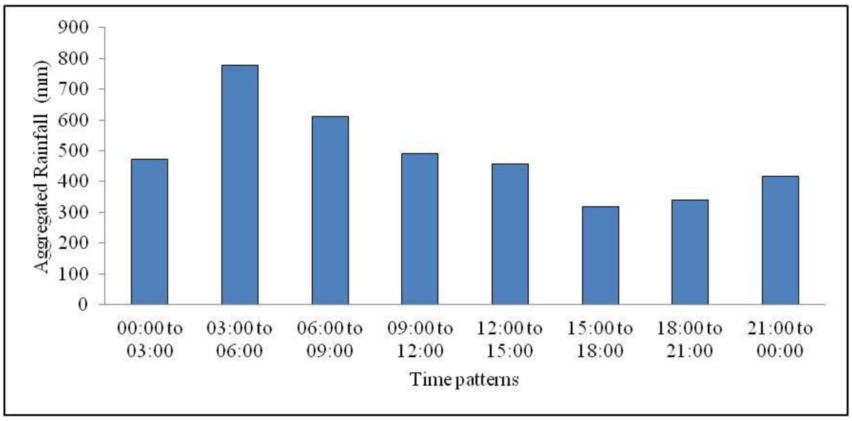

Fig 2. Aggregated rainfall by third hourly time patterns.

Table 3. Bark consumptions in the five treatments from June 2015 to May 2016.

Treatment	Average bark consumption (cm)	Monthly bark consumption (cm)
T1	20.67 c (100)	2.58 (100)
T2	25.52 a (123)	3.19 (123)
T3	22.69 b (110)	2.11 (82)
T4	15.9 e (77)	1.48 (57)
T5	17.3 d (84)	1.61 (62)

Means with different letter in the same column are significantly different at $p\leq0.05$, computed by Duncan's Multiple range Test. Figures in parenthesis indicate percentage of bark consumption compared to that of T_1.

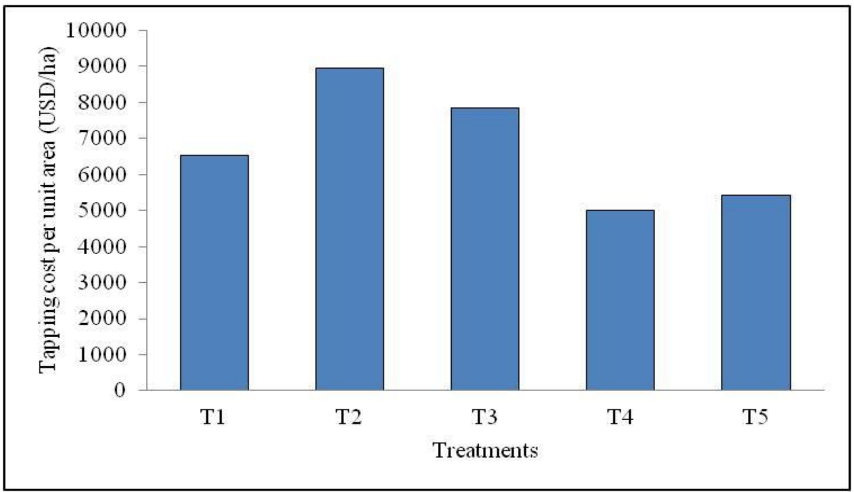

Fig 3. Tapping costs per unit area of the five treatments.

Table 4. Tapper requirements in the five treatments.

Treatment	No. of tapped tree per day	No. of tapper required for 4000 tapped trees
T_1	2000	3 (100)
T_2	2667	4 (133)
T_3	2000	3 (100)
T_4	1333	2 (67)
T_5	1333	2 (67)

Task size = 700 trees; Number of trees for tapping = 4000 trees; Figures in parenthesis indicate percentage of tapper requirement compared to that of T_1.

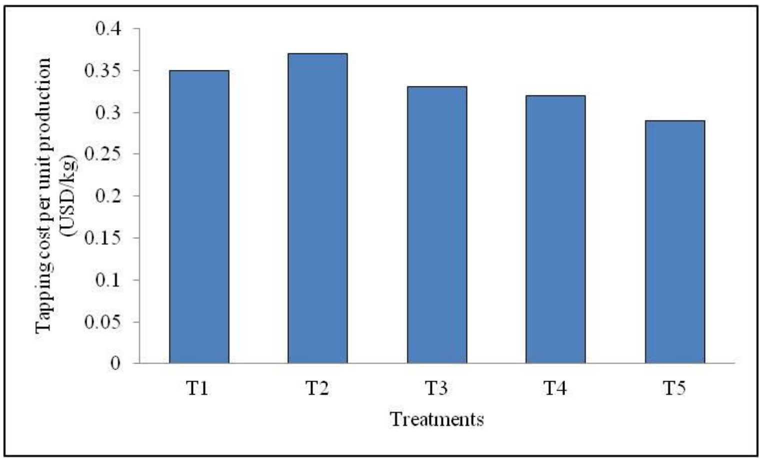

Fig 4. Tapping costs per unit production of the five treatments.

Table 5. Summary of the five treatments.

Treatment	Length of tapping cut	Tapping frequency	Tapping in the rainy season	Using rainguard	Stimulation
T_1	S/2	d2	No	No	No
T_2	S/2	2d3	No	No	No
T_3	S/2	d2	Yes	Yes	No
T_4	S/2	d3	Yes	No	ET2.5% Pa1(1) 3/y (m)
T_5	S/2	d3	Yes	Yes	ET2.5% Pa1(1) 3/y (m)

Stimulation times: June, November and December.

Since the tapper requirement mainly depends on the number of tapped tree per day, d3 frequency tappings, T_4 and T_5, needed only 67% of tapper requirement by d2 frequency tapping, T_1 and T_3. However, the requirement of 2d3 frequency tapping, T_2, was 33% higher than that of d2 frequency tapping (Table 4). It is consistent with the report of Kudaligama et al. (2010) that reduction in tapping frequency from d2 to d3 reduced the number of tapper requirement by 33%. LFRTS enables not only reducing the number of tapper requirement but also increasing land-man ratio and tapper productivity (Nugawela et al., 2000; Soumanhin et al., 2010; Mahyao et al., 2014) because under this system, the trees in a certain task get more resting time for latex regeneration, and the tapper could be assigned to tap other tasks in the following two days while the first task is resting. Because of higher tapper productivity under LFRTS, tapper incomes or wages could be increased. As the result, tapping employment would be more competitively attractive and could address problems of skilled tapper shortage (Chan et al., 1983; Hassan et al., 1999).

Tapping cost

The total tapping cost per unit area of high frequency rubber tapping system, T_2, was the highest during the study period because of high number of tapped trees a day. LFRTS with rainguard, T_5, cost 5433 USD/ha during the year which was 17% and 39% lower than that of T_1 and T_2, respectively (Fig 3) because of less number of tapped trees a day in the area and less number of tapper requirement. Regarding the average tapping cost per unit production, the high frequency rubber tapping system, T_2, cost higher than that of other treatments. The cost of T_5 was 0.29 USD/kg which was 17% and 22% lower than that of T1 and T2, respectively (Fig 4) because under LFRTS, its tapper productivity was higher and the number of tappers required was lesser. In Sri Lanka, under LFRTS, S/2 d3, due to higher tapper productivity, the cost of production per unit area could be reduced by 20% of that of the conventional tapping system, S/2 d2 (Nugawela et al., 2000). Although there were costs of stimulation, rainguard and fungicide under the LFTS with rainguard, these costs could be compensated easily by its cost saving due to the lower cost of production (Kudaligama et al., 2010; Thomas, 2013).

Materials and Methods

Location of the experiment

The experiment was conducted at a rubber estate located at 16.00° N and 97.63° E, and 111 m of altitude in Thanbyuzayet Township, Mon State, Myanmar. The study was carried from June 2015 to May 2016.

Plant material

The experiment was conducted on BPM 24 clone planted in 2005 at 3 m x 7 m spacing on flat land and opened for tapping in 2011. Tapping for the experiment was carried out on virgin bark of second basal panel (BO-2) of the trees at 120 cm height from the ground.

Experimental design and treatments

Five treatments of different tapping systems were evaluated with four replications in Randomized Complete Block Design (RCBD). Each plot consisted of 60 trees in 6 rows with 10 trees and the total number of trees conducted was 1200 in 20 plots. The summary of the five treatments are shown in Table 5.

Installation of the rainguard

The rainguards were fixed in the second week of May before the starting of the rainy season. Mancozeb fungicide was sprayed on the tapped panel of the trees tapped with the rainguards at weekly interval during the rainy season to prevent panel diseases.

Traits measured

By using a mini weather station at the experiment site, daily rainfall, cumulative rainfall, raining patterns and number of raining days were identified. Fresh latex from each plot was collected on every tapping day to determine daily rubber yield of every treatment in gram per tapping per tree. Bark consumption measurement was also carried out in the end of May 2016.

Tapper requirement and tapping costs based on unit area and unit production were calculated according to the different tapping systems, their yields resulting from the experiments, and local tapper payment rates and practices resulting from interviews and field surveys. The field surveys were carried out to know the practices of local farmers, and current conventional tapping systems practiced in the area. The tapping costs were calculated for piece work payment system based on number of tapped trees which is the most prevalent tapper payment system in the area.

Statistical analysis

An analysis of variance was carried out to compare the data of the five treatments including daily yields, cumulative yields and average bark consumptions with Sirichai Statistics 6.00 and Duncan's Multiple Range Test, at $p \leq 0.05$.

Conclusion

According to the observations on rainfall and raining pattern, regular tapping could not be carried out without rainguard during the rainy season in the area. Under rainguard tapping, S/2 d3 tapping system is more effective than the conventional tapping system, S/2 d2, in terms of tappable days during the rainy season. In terms of yield performances, the daily yield of d3 tapping system was 23% and 30% higher than those of d2 and 2d3 tapping systems. With higher tapper productivity throughout the year, the cumulative yield of LFRTS with rainguard was comparable with that of the conventional tapping system, S/2 d2. In addition, its lower bark consumption can prolong the economic lifespan of the tree. In terms of economic performance, the LFRTS with rainguard could reduce 33% of the tapper requirement of the conventional tapping system and solve the problem of tapper shortage. The tapping costs both based on unit area and unit production of the LFRTS with rainguard were 17% lower than that of the conventional tapping systems. In conclusion, the study revealed that an optimum yield could be harvested with low cost of production practically throughout the year with potential longer economic lifespan of the tree by implementing the LFRTS with rainguard. It could be a solution to address the problems of the rubber farmers in the high rainfall area of Myanmar.

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