Natural Rubber Research, 21 (1&2): 84-91, 2008

LOW WINTER TEMPERATURE REST BASED TAPPING SYSTEM FOR TRIPURA AND NORTH BENGAL

Gitali Das, Shammi Raj*, S.K. Dey and D. Chaudhuri*****

Regional Experiment Station, Nagrakata, Jalpaiguri, West Bengal - 735 995, India
*Rubber Research Institute of India, Kottayam-686 002, Kerala
**Regional Research Station, Rubber Research Institute of India, Kunjaban - 799 006, Agartala, Tripura, India
***Regional Research Station, Rubber Research Institute of India, Guwahati - 781 006, Assam, India

Das, G., Raj, S., Dey, S. K. and Chaudhuri, D. (2008). Low winter temperature rest based tapping system for Tripura and North Bengal. *Natural Rubber Research*, 21(1&2): 84-91.

Formulation of an appropriate tapping system is one of the prime requirements in North East India because of the prevalence of low winter temperature, heavy rain and high wind speed unlike that in the traditional rubber growing regions of India. The peak yielding periods mostly coincide with periods of low temperature in this region. In order to optimize the tapping in this region, three different trials were carried out in two agroclimatic zones namely, Agartala in Tripura and Nagrakatta in North Bengal. The treatments were two tapping systems (½Sd/2 and ½Sd/3) and low winter temperature rest based on different minimum temperature regimes. The study was conducted for five years on a high yielding clone (RRIM 600). It was observed that under the ½Sd/2 systems of tapping 15-15°C and 12-12°C rest regimes were the best combinations for Agartala and Nagrakatta respectively. The post-rest period (summer) yield under these regimes were higher.

Another experiment was conducted in a farmer's field in Nagicherra, Tripura with the clone RRII 105 following the ½ Sd/2 system of tapping and rest regimes of 10-10°C, 12-12°C and 15-15°C with trees tapped without rest as control. Under rainguarded conditions the yield in the 12-12°C rest regime was found to be on par with that of 15-15°C for this clone.

Key words: *Hevea brasiliensis*, Low temperature rest, North East India, Tapping system, TPD, Yield.

INTRODUCTION

The climatic conditions in North East (NE) India where rubber (*Hevea brasiliensis*) cultivation has been introduced is different from that in traditional rubber growing regions and hence warrant development of appropriate technology for crop harvesting. Temperature extremes are one of the important climatic limitations in this region.

Latex production in *H. brasiliensis* is affected by localized environmental factors like temperature (Jiang, 1988) which influences tapping (Shuochang and Yagang, 1990), soil moisture deficit, relative humidity, wind speed, sunshine hours and slope of land (Alliang, 1984). A 10 day mean minimum temperature of over 22°C is conducive for latex regeneration and an ambient temperature of 18-24°C coincides with optimum yield (Shangphu, 1986; Shuochang and Yagang, 1990). Photosynthesis is impaired at 10°C, and below 5°C irreversible frost-damage appears (Wenxian and Yanqing, 1990). A continuous improvement in yield under ½S d/3 system of

Correspondence: Gitali Das (Email: gitalidas@rubberboard.org.in)

tapping is observed following the annual rest months (Shivakumaran and Pakianathan, 1983). Tapping rest based on minimum temperature regime of 15-15°C under the d/2 system of tapping reduces the tapping panel dryness (TPD) in the NE region (Das *et al.*, 2005). The present study is to assess the effect of low temperature rest treatment on the yield of rubber in the NE region.

MATERIALS AND METHODS

The experiment was laid out in a plantation of the clone RRIM 600 spaced at 5x5 m with rubber trees (girth 60 to 70 cm) in the fourth year of tapping, at the Regional Research Station of Rubber Research Institute of India (RRII) at Agartala, Tripura (23° 53'N, 91° 15'E, 20m MSL), and another in the first year of tapping (girth 50 to 55 cm) at the Regional Experimental Station of RRII at Nagrakata, North Bengal (26°43'N, 88°26'E, 69m MSL). The experiments were conducted in a two-factor RBD replicated three times with fifteen trees per plot for a five year period. Two systems of tapping (½Sd/2 and ½Sd/3) were included as one factor and the temperature based tapping rest regimes were considered as the other factor of the experimental design. Temperature regimes were considered on the basis of minimum weekly temperatures. The tapping rest period commenced when winter temperature fell below 20°C and resumed when temperature went up above 20°C for three consecutive days (Das *et al.*, 2005). Similar procedure was adopted for all the other regimes of tapping rests. The temperature regimes (stop-start°C) chosen were 20-20°C, 15-15°C, 10-10°C and 18-18°C, 15-15°C, 12-12°C for Agartala and Nagrakata respectively. Trees tapped continuously without rest formed the control. The experimental plants were not subjected to routine refoliation-defoliation rest. All cultural practices as recommended by the Rubber Board (2001) were followed.

Dry cup lump yield from each plant was recorded on weekly basis. For calculating the actual yield, a regression equation was fitted between the cup lump weight and yield of rubber processed into sheets to estimate the real cup lump weight devoid of entrapped moistures (Raj *et al.*, 2005). The regression equation between the dry cup lump weight and sheet weight adopted for both the locations was $Y = 0.913x + 0.656$ ($R^2=0.95$), where as 'x' denotes the dry cup lump weight and 'Y' the sheet weight. The tapping panels were rainguarded and protected from external hazards using panel protectants. The yield was computed for the four seasons namely summer (March to May), monsoon (June to August), post-monsoon (September to November) and winter (December – February). The occurrence of TPD incidence was monitored every six months and estimated according to Das *et al.* (2005). Tapping was stopped for plants affected by severe TPD, allowing them rest and reopened after 5 to 6 months. Girth and tapping panel length measurements were recorded annually.

Data on daily meteorological parameters *viz.*, minimum and maximum temperature, relative humidity, wind speed, sunshine hours and rainfall were recorded in nearby meteorological stations and mean weekly values were computed. The yield data were subjected to analysis of variance.

In another experiment carried out in Nagicherra, Agartala (P. C. Chandra Rubber Plantation) ½Sd/2 system of tapping was adopted. The experiment was in RBD with five replications per treatment having 25 plants of similar girth in each replication. In this experiment the tapping was stopped when the three day mean minimum temperature went below the chosen threshold limits followed by the defoliation-refoliation rest after which tapping was resumed. The temperature regimes of rest chosen were 10^{0}C, 12^{0}C, 15^{0}C and control was with the normal defoliation-refoliation rest. Daily yield data in terms of smoked sheet weight from each block was collected. The experiment was continued for five years. TPD scoring was carried out at three month intervals. The temperature in the experimental field was recorded daily.

RESULTS AND DISCUSSION

Monthly distribution of maximum and minimum temperature in Agartala remained consistently higher than that of Nagrakata (Fig. 1a). Nagrakata is situated in the foothills of the Himalayas and so shows a much lower mean monthly minimum temperature

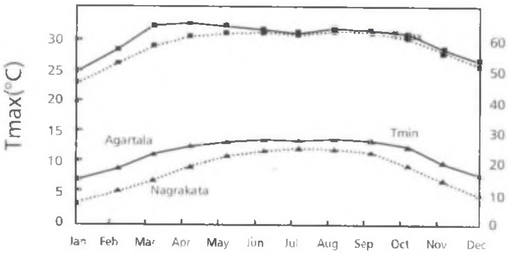

Fig. 1a. Distribution of maximum and minimum temperatures (^{0}C) over months (mean of 10 years)

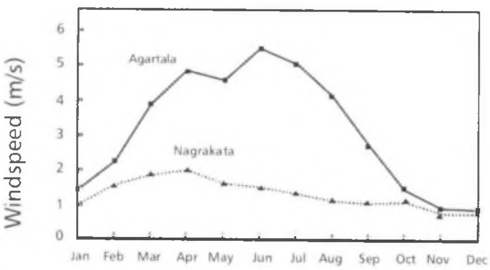

Fig. 1b. Pattern of wind speed (m/s) over months (mean of 10 years)

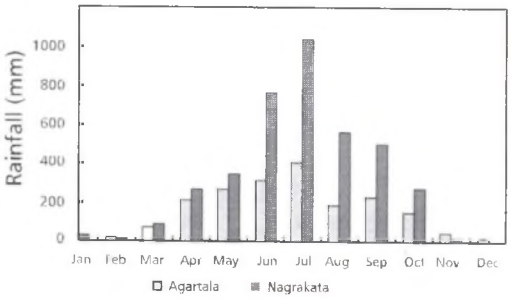

Fig. 1c. Distribution of total rainfall (mm) over month (mean of 10 years)

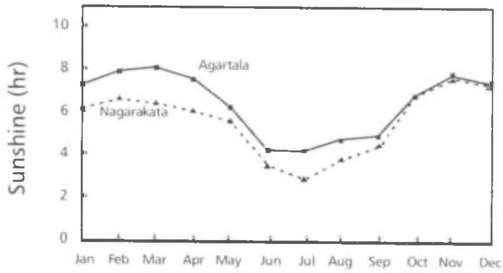

Fig. 1d. Distribution of sunshine duration (hh) over months (mean of 10 years)

compared to Agartala throughout the year. The period below 15^{0}C for Agartala generally is from mid-December to February (10 to 12 weeks) while in Nagrakata it is from October to April (15 to 17 weeks). There is a rapid fall in minimum temperature from September to December at Nagrakata compared to that at Agartala.

It is reported that longer duration of low temperature (Sehgal *et al.*, 1992) and high wind speed affects the productivity rubber trees (Shuochang and Yagang, 1990). The average wind speed (Fig. 1b) at Agartala (5.5 m/s) was higher compared to Nagrakata (1 m/s) during July, but during winter both the places experienced low velocity wind.

Figure 1c and d shows that Nagrakata with a low mean daily sunshine hour receives a higher rainfall every month with a mean

Table 1. **Loss in tapping days in relation to control for rest treatment under different tapping systems**

Agartala			Nagrakatta		
Treatment	½Sd/2	½Sd/3	Treatment	½Sd/2	½Sd/3
10-10°C rest	8	6	12-12°C rest	49	33
15-15°C rest	38	25	15-15°C rest	68	45
20-20°C rest	58	38	18-18°C rest	76	50

annual rainfall of 3900 mm compared to Agartala with 1896 mm.

The broad difference in the minimum temperature pattern was reflected on the number of tapping days (Table 1). The loss in tapping days in Nagrakata for the 15-15°C rest was much more than in Agartala. Loss in tapping days was higher in Nagrakata for other temperature regimes also.

Dry rubber yield (kg/ha/year) based on the two tapping systems for both the locations are depicted in Figure 2 a and b. In Agartala, there was an increase in yield with 10-10°C and 15-15°C rest under ½Sd/2 tapping, which however came down to the level of the control at the 20-20°C rest. Under ½Sd/3, there was a general decline in yield for both the locations and the rest treatment did not improve yield under this tapping system. The data from Agartala revealed that the mean yield in control trees over the years was on par for both the systems of tapping. Thus ½Sd/2 system with 15-15°C rest regime recorded higher yield among the treatments.

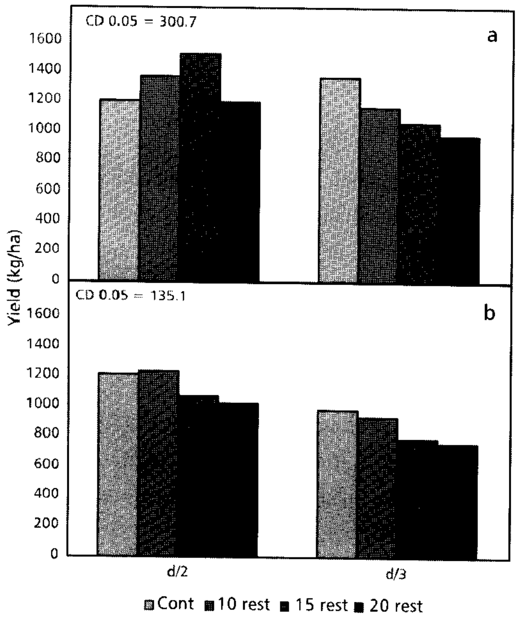

Fig. 2. Pattern of projected dry rubber yield (kg/350 plants/year) in two different locations of North East India a. Agartala b. Nagrakata

In Nagrakata (Fig. 2b), the control plot yield under ½Sd/3 tapping system was significantly lower than that in ½Sd/2 system. Under both these systems of tapping, the yields of control and 12-12°C rest regimes were on par while the yield under other regimes were significantly lower. This shows that the 12-12°C rest regime with minimum duration of rest could be preferred at Nagrakata.

The effect of low temperature rest was prominent when yields were considered on a seasonal basis (Fig. 3a & b). The yield under ½Sd/2 control was low during the summer and monsoon periods compared to post-monsoon and winter periods in Agartala. Similar trend was also observed for the 10-10°C rest regime. However, during the summer period the yield under the treatment in 15-15°C rest and 20-20°C rest regimes were significantly higher. This trend continued during the monsoon and post-monsoon periods with some variations. For the ½Sd/3 system, an

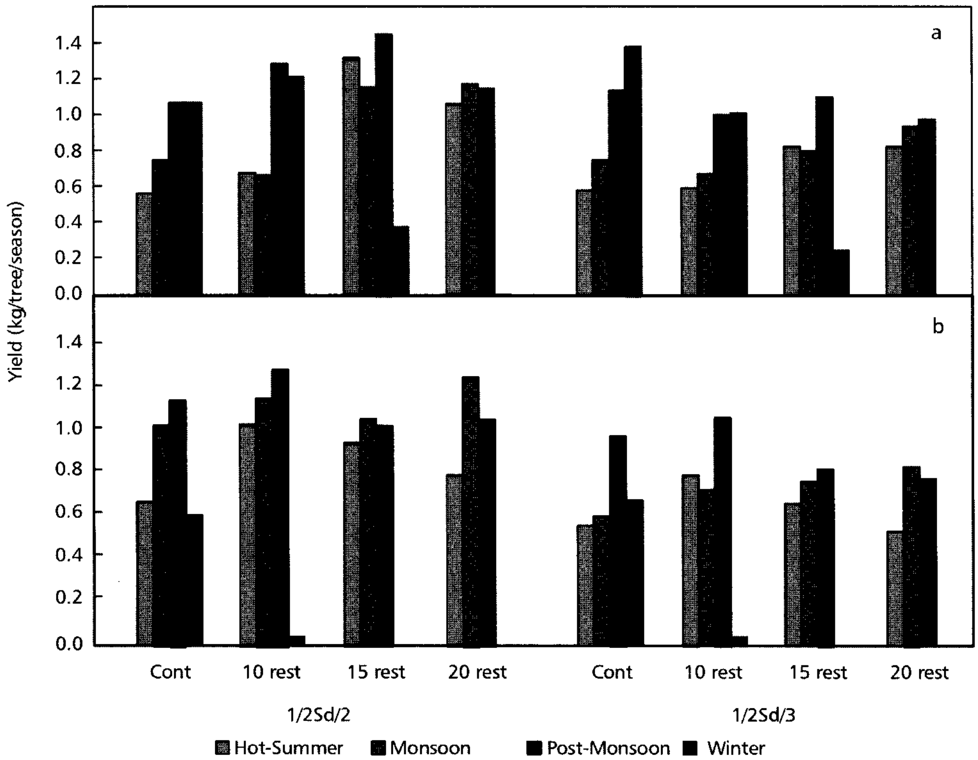

Fig. 3. Seasonal variation of the yield pattern in the two locations
a. Agartala b. Nagrakata

increasing trend was observed from the summer to winter period in control and 10-10⁰C rest regime while it declined in the other treatments during winter. Under the ½Sd/2 system of tapping, except for control treatment at Nagrakata the trend in yield was similar although the winter yield was very low. The general impact of rest treatment was quite prominent in the 12-12⁰C rest at Nagrakata was similar to that of 15-15⁰C rest at Agartala for the½ Sd/2 system of tapping.

The TPD incidence (Fig. 4a and b) was found to be higher for the control than the rest-treatments under both the tapping systems due to inadequate reconstitution of cellular organelles (Jacob *et al.*, 1994). Reduction in the incidence of TPD was observed when low winter temperature based tapping rest was imposed (Das *et al.*, 2005) showing that the tapping intervals under ½Sd/2 and ½Sd/3 systems were not enough during the winter period. Seasonal variation in the occurrence of TPD and its association with low winter temperature has been reported (Das *et al.*, 2005). TPD incidence was lower under the 15-15⁰C rest and 20-20⁰C rest regimes (<6%) for both tapping systems and locations.

The five years average yield (Table 2) from the growers' field at Nagicherra in control was significantly higher than that of the 15-15⁰C rest regime but was on par with that of 12-12⁰C and 10-10⁰C regimes.

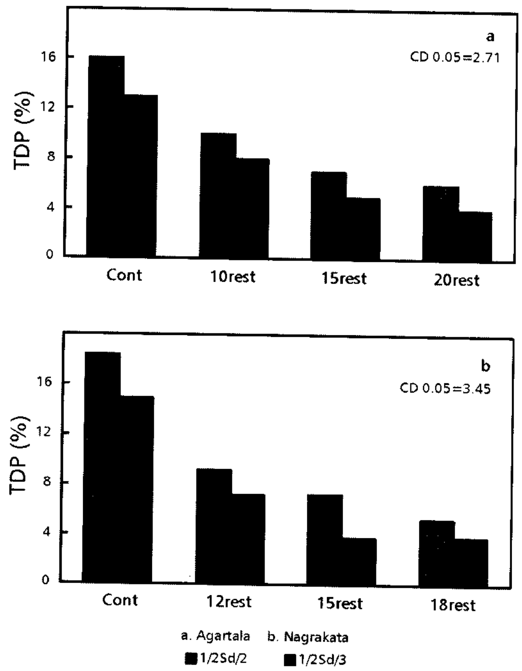

Fig. 4. Pattern ofTDP in different tapping systems with winter tapping rests a. Agartala, b. Nagrakata

The low temperature based rest in this case included the wintering rest also. For the clone RRIM 600 adoption of low winter temperature based rest tapping system (15°C) without wintering rest was reported to improve yield (Das *et al.*, 2000; Das *et al.*, 2005).

It was observed (Table 3) that the yield difference between control and 15-15°C rest was significant from September to May.

Table 2. **Pattern of yield in ½Sd/2 system of tapping in combination of low winter temperature rest at Nagicherra, Agartala**

Rest treatments	Yield (kg/ha)	Number of rest days
15-15°C rest	1037.5	105
12-12°C rest	1210. 3	90
10-10°C rest	1201.8	77
No temperature rest	1297.3	75
CD (P= 0.05)	104.71	

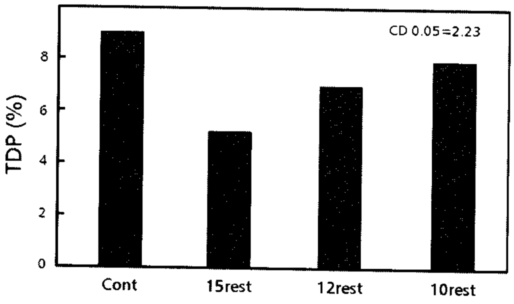

Fig. 5. Pattern of TDP in different rest treatments at Nagicherra, Agartala

Similar observation was noticed between control and 12-12°C rest where significant yield difference continued from September to July. In case of 10-10°C rest, significant difference was observed only during October and November. At Nagicherra, the occurrence of TPD (Fig. 5) was found to be low in 15-15°C rest regime treatment which may be due to the long span of rest that included the low temperature based rest and routine wintering rest. In other treatments *viz.*, 12-12°C rest and 10-10°C rest regims, the incidence ofTPD was higher than in the 15-15°C rest regime. TPD of 10-10°C rest was at par with that of control. This shows that tapping rest of a few weeks during winter considerably decreases the progression ofTPD (Das *et al.*, 2005). Besides, season, drought and quality of soil can also influence TPD incidence (Jacob *et al.*, 1994). The exhaustion can be overcome by giving rest to the trees or by adopting a lower tapping frequency (Jacob *et al.*, 1994).

CONCLUSION

The study on the low temperature rest based tapping system for cold-prone regions like Agartala in Tripura and Nagrakata in North Bengal revealed that the yield pattern

Table 3. **Difference in monthly yield (kg/350 trees) under low winter temperature rest treatments at Nagicherra, Agartala.**

Month	Yield difference in different treatments		
	Control – 15 rest	Control – 12 rest	Control – 10 rest
April	-15.85 **	-17.12 **	-01.26
May	-08.88 *	-17.56 **	06.05
June	-02.72	-10.48 *	06.32
July	-00.70	-09.08 *	04.03
August	04.46	-06.09	06.29
September	10.71 *	-08.56 *	07.67
October	11.48 *	-10.72 *	11.2 *
November	23.83 **	-08.51 *	09.55 *
CD (P= 0.05)	08.26		

*Significant at P≤ 0.05 **Significant at P≤ 0.01

differs distinctly in two locations. In Agartala, the yield under ½Sd/2 and ½Sd/3 with 12-12°C (control) was similar but in Nagrakata the yield under ½Sd/2 was better than ½Sd/3. The combination of ½Sd/2 with 12-12°C rest ranked high in Nagrakata and the farmer's field at Agartala. The incidence of TPD was 7 per cent and 9 per cent at Agartala and Nagrakata respectively. Adoption of low winter temperature rest based tapping systems appear to be beneficial in North East India.

ACKNOWLEDGEMENT

The authors thank Dr. Y.Annamma Varghese, Joint Director, Crop Improvement, RRII, Kottayam for her encouragement during the initial stages of the experiment. Dr. N.M. Mathew, former Director, RRII , Kottayam for providing necessary facilities and Dr. K.R. Vijayakumar, Joint Director, RRII, Kottayam for his suggestions. Authors are thankful to the scientists who were in charge at RRII Regional Experiment Station, Nagrakata, Field staff and workers of research farms at Agartala and Nagrakata and to M/s.P.C. Chandra & Sons, Nagicherra, Agartala for their permission to conduct the experiment on their plantation.

REFERENCES

Alliang, J. (1984). A geo-ecological study of rubber tree cultivation at high altitude in China. *Proceedings of the International Rubber Conference.* 75years of Rubber Research in Sri Lanka. pp. 117-130.

Das, G., Raj, S., Pothen, J., Dey, S.K. and Varghese, Y.A. (2000). Exploitation of *Hevea* under low temperature stress situations: Studies on exploitation systems giving tapping rests based on drop in minimum temperature. *Recent Advances in Plantation Crops Research.* (Eds. N. Muraleedharan and R. Raj Kumar). Allied Publications, New Delhi. pp. 150-156.

Das, G., Raj, S. and Dey, S.K. (2005). Seasonal variation in occurrence of TPD in the agroclimatic condition of Tripura. Workshop on Tapping Panel Dryness Syndrome. In: *Proceedings of International Rubber Research and Development Board (IRRDB),* Kottayam, India. pp. 68-73.

Jacob, J. L., Prevot, J.C. and Lacrotte, R. (1994). Tapping panel dryness in *Hevea brasiliensis. Plantations Recherche Development,* 1(3):22-24.

Jiang, A. (1988). Climatic and natural production of rubber (*Hevea brasiliensis*) in Xishuangbannam, southern part of Yunan province. *Chinese International Journal of Biometeorology,* 32: 280-282.

Raj S., Das G., Pothen J. and Dey S. K. (2005). Relationship between latex yeild of *Hevea brasiliensis* and antecedent environmental parameters. *International Journal of Biometeorology*, 49(3): *189-196.*

Rubber Board (2001). Rubber Grower's companion, The Rubber Board, India, pp. 14-34

Sehgal, J.L., Mandal, D.K., Mandal, C. and Vadivelu, S. (1992). Agro-ecological regions of India. In: Technical bulletin no. 24. *National Bureau of Soil Survey and Land Use Planning (ICAR)*, India. pp. 88-90.

Shangphu, L. (1986). Judicious tapping with stimulation based on dynamic analysis of latex production. *Proceedings of IRRDB, Rubber Physiology and Exploitation Meetings*, SCATC, Hainan, China. pp. 230-239.

Shivakumaran, S. and Pakianathan, S. W. (1983). Evaluation of exploitation systems incorporating tapping and stimulation rest. *Proceedings of Rubber Research Institute, Malaysia Planters' Conference*, Kuala Lumpur. pp.105-125.

Shuochang, A. and Yagang, G. (1990). Exploration of the high yield physiological regulation of *Hevea brasiliensis* in Xishuangbanna. In: *Proceedings of International Rubber Research and Development Board (IRRDB) Symposium*, Kunming, China. pp. 83-92.

Wenxian, X and Yanquing, P. (1990). Physiology and Exploitation. In: *Proceedings of International Rubber Research and Development Board (IRRDB) Symposium.* Kunming, China. pp. 49-58.