Recent Advances in Plantation Crops Research, 2000, pp.150-156.

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EXPLOITATION OF *HEVEA* UNDER LOW TEMPERATURE STRESS SITUATIONS STUDIES ON EXPLOITATION SYSTEMS GIVING TAPPING RESTS BASED ON DROP IN MINIMUM TEMPERATURE

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Low temperature being the prime cause for late dripping in non-traditional belt of northeast India. An experiment was conducted incorporating three systems *viz.* ½ S d/1, ½ S d/2 and ½ S d/3 with three periods of tapping rests based on minimum temperatures of 20-20^{O}C, 15-15^{O}C and 10-10^{O}C and compared with a control. Though the ½ S d/1 system for all the combinations showed a high annual yield, the occurrence of tapping panel dryness (TPD) was found to be relatively high. The 15-15^{O}C rest covers around 20 per cent of the peak yields in comparison with the continuous tapping systems. Analysis of yield showed a high significant relation between the sub-plot treatments of the temperature regimes. Mean yield was high (30.8 gm/tree/tap) for the continuous system of ½ S d/3 tapping system which also registered the same in the 20-20^{O}C rest. With a low incidence of TPD (5%), the 15-15^{O}C minimum temperature regime, for the ½ Sd/2 system of tapping, in general, showed an optimum system for exploitation of latex yield during cold season under this non-traditional agroclimatic condition. Nevertheless, basic knowledge of the effects of rest periods during the cold season with an optimum system of tapping, coupled with a lack of long term deleterious effects, would necessarily render exploitation methods to tackle and overcome several prevailing limitations in the region.

INTRODUCTION

Effects of exploitation system towards realization of an optimum and sustainable latex yield in rubber tree are yet to be thoroughly elucidated especially in the non-traditional belts of the NE India which experiencing low temperature stress during winter season. Latex production is usually affected by many environmental factors such as temperature (Shuochang and Yagang, 1990), soil moisture, atmospheric humidity, wind speed as well as sunshine (Ailiang, 1984). Low temperature is considered as a prime cause for the late dripping resulting in a high incidence of the tapping panel dryness (TPD) syndrome that adversely affects the yielding ability of the tree (Vijayakumar *et al.*, 1991). Abnormal symptoms of tapping panel dryness coupled with late dripping during winter are commonly noted in this region, unlike that of its traditional counterparts. General system followed in this region is ½ Sd/2 6d/7 system with rests during the defoliation and refoliation

*RRII, Central Experimental Station, Chethakkal, Kerala

periods. Close monitoring of weekly yields based on the standard meteorological weeks (SMW) can provide ample evidences about the tendency of the tree to yield during different periods of the year. Considering the prevailing minimum temperatures of less than 10^{0}C often exists for more than a week, a study has been undertaken with respect to yielding pattern of the plant at different rest periods and occurrence of TPD to suggest an appropriate package of exploitation system for this region. In this experiment, the usual period of rest was not given during the defoliation-refoliation time of February to March.

MATERIAL AND METHODS

An experiment was conducted at Taranagar Farm, Regional Research Station, Agartala, Tripura (23^{o}53'N 91^{o}15'E). Mature trees of RRIM 600 spaced at 5 x 5 m in the fourth year of tapping (BO1 panel) under the ½S d/2 system were selected for the experimental purpose. Rest periods based on three temperature regimes, 20-20^{o}C, 15-15^{o}C and 10-10^{o}C in combination with tapping intensities of ½ S d/1 7d/7, ½S d/2 7d/7 and ½Sd/1 7d/7 (including Sundays) were experimented adopting a split plot design with 10 trees/plot and replicated two times. A control plot was incorporated for each system with continuous tapping round the year without winter rest. Tapping was stopped for the respective plots when the weekly minimum temperatures went below the respective 20, 15 and 10^{o}C and then tapping was resumed when the minimum temperatures went above those respective temperatures. Cup-lumps were collected (dried and weighed) at every standard meteorological weeks for a period of two years beginning from the 41st SMW (second week of October, 1995) to the 40th SMW (first week of October, 1997). Experimental plots were rain-guarded, so that no tapping days were lost due to rainy days. Absolute/actual tapping intensities (AI) were calculated for all the treatments according to the method of Lukman (1983) considering the tapping days after initiation of the experiment, i.e. from first week of October, 1995; the formula used was AI = [(4 x length of tapping cut x actual number of tapping days)/total number of tapping days)*100].

Periodical scoring of partially affected TPD trees and the extent of tapping panel area dried due to the syndrome were monitored at every six month intervals. Percentage of partial TPD was considered where the plants exhibited syndrome above 50 per cent at the end of the two year period. Per cent trees affected by TPD was calculated as per the formula, per cent TDP = [(Total number of >50% TPD affected plants/ Total number of plants)*100]. Weekly mean of maximum and minimum temperatures, relative humidity, wind speed, sun shine hours, rainfall and evaporation were collected during the entire period of study. Periodical girth measurements were made every year and the tapping panel length of individual trees was recorded once in six months and also when panel sides were changed. Data on defoliation/refoliation rates were also recorded.

Weekly cup-lump weights per tree taken from all the experimental plots over the two year period were subjected to data checks and for filling up gaps in the data set following fundamental procedures for statistical checks. Total yield (kg/ha/year) was obtained from twelve plots in two replicates were subjected to the analysis of variance. A successive percentage yield increment per uniform tapping panel length over a previous week (relative yield rate/week) was computed for the period.

RESULTS AND DISCUSSION

Experiment was designed with tapping systems as the main plot treatment and the weekly minimum temperature based rests as the sub-plot treatment. Yield data revealed significant interactions between subplots (Table 1) while differences were noted at 10 per cent level amongst the main plots probably because of the sampling of only two years. No significant differences were noted between the continuous

Table 1. Mean annual yield (kg/ha) under different temperature regimes

Tapping system	No rest	10-10°C rest	15-15°C rest	20-20°C rest	Mean (B)
1/2 Sd/1	2210	2057	1954	2070	2073*
1/2 Sd/2	1525	1867	1620	1332	1586
1/2 Sd/3	1672	1441	1046	1100	1315
Mean (A)	1802	1788 NS	1540*	1501*	-

* Significant at 0.05 level; CV (%) A = 15.3 and B = 8.4

tapping and the 10°C rests for all systems of tapping. A distinct temperature profile is seen throughout the two year period (Fig.1). Mean weekly minimum temperatures fluctuated from 26.0 to 7.6°C.

Mean annual yield over two year period showed that the ½S d/2 systems in the 15-15°C and the 20-20°C regimes were the lowest (26.8 and 26.7 gm/tree/tap, respectively) in comparison with the other tapping systems (Fig.2). However, this was not observed in other two temperature regimes (*viz.* tapping without rest and 10-10°C regimes) of ½S d/2 where it showed an increase of yield with the systems of tapping. It is also evident that for the 15-15°C and the 20-20°C rests, the ½S d/3 system showed higher yield than that of the ½S d/1 and the ½S d/2 system. Further, from the figures 3 a, b and c which gives the yield pattern in different tapping systems, it is seen that

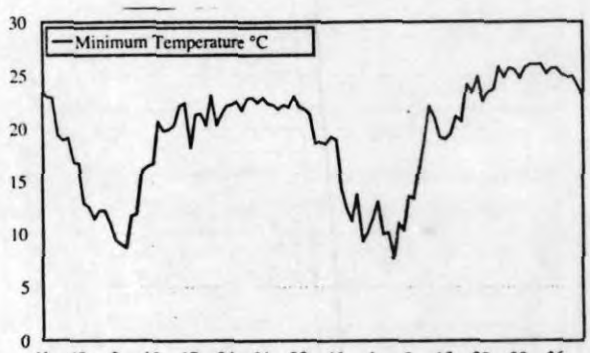

Fig.1. Weekly minimum temperature over 104 weeks starting from 41st standard meteorological week

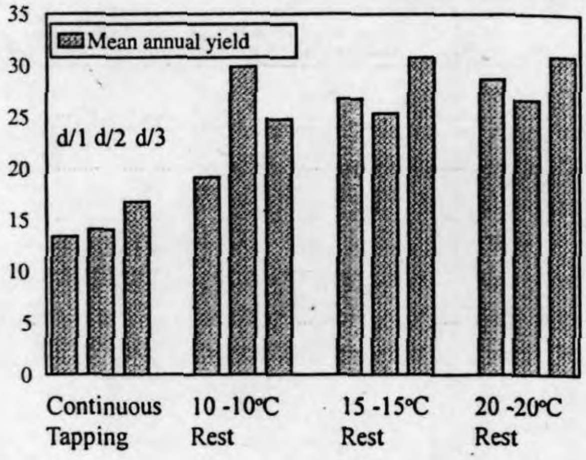

Fig.2. Mean annual yield (g/tree/tap) for the three systems of tapping at different temperature regimes

though the plants receive a uniformly distributed high monsoon rainfall in Agartala (experiencing an average of more than 280mm of monthly rainfall), latex production is low during the month of June-July generally picks up from the month of August till December or mid-January.

From the continuous march of weekly yields over a two year period, the maximum yield (420 trees/ha) was found in between the 40th SMW (October1st week) and the 52nd SMW (December 4th week) with comparatively low yields in between the 10th SMW (March 2nd week) and 21st SMW (May 3rd week). One of the reasons for high yield during November can be due to the usual late dripping that starts from the 2nd week of November and lasts till the 2nd week of February. In the ½S d/2 system, the 10-10°C category gave the highest yield increase over that of the continuous system of tapping (31.8% increase). It is quite pertinent to note that the 20°C rest falls on weeks where maximum yield is being experienced i.e. in the 4th week November. However, an average temperature of 18°C is regarded as the lower limit of optimal temperature for rubber growth, so that the tree's physiological processes, such as photosynthesis, is not hampered in producing photosynthetic products for the whole plant (Ailiang, 1984). The broad regime of 20-20°C was seen to be in between the 48th SMW (4th week of November) and the

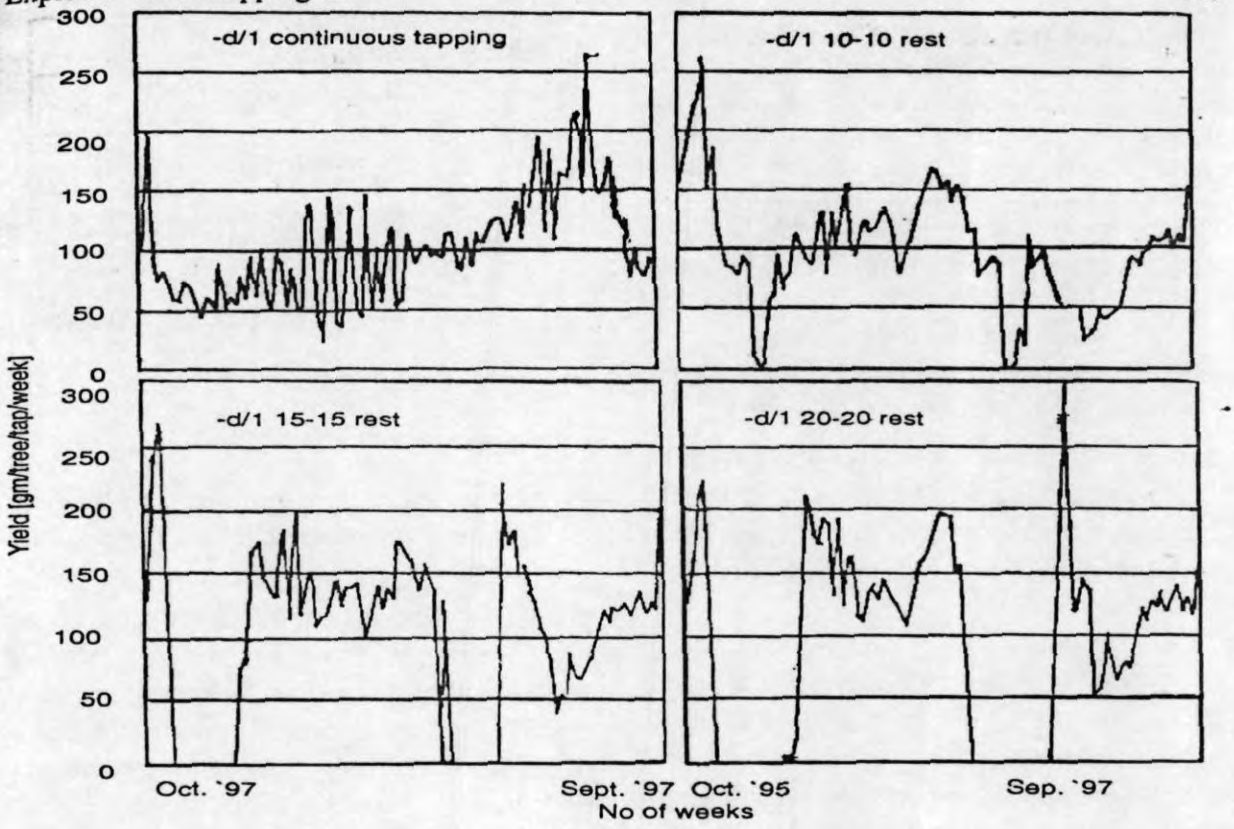

Fig. 3a. Mean yield pattern in d/1 tapping system at different temperature regimes

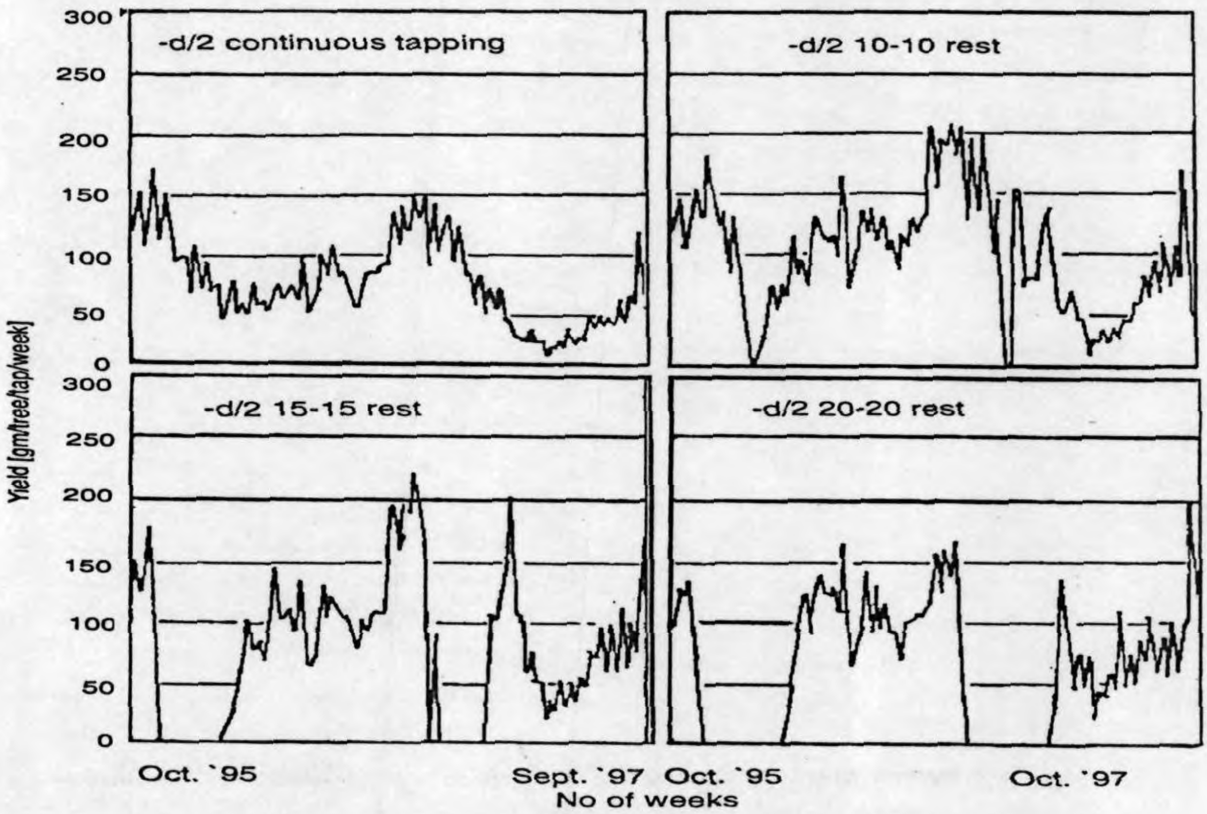

Fig. 3b. Mean yield pattern in d/2 tapping system at different temperature regimes

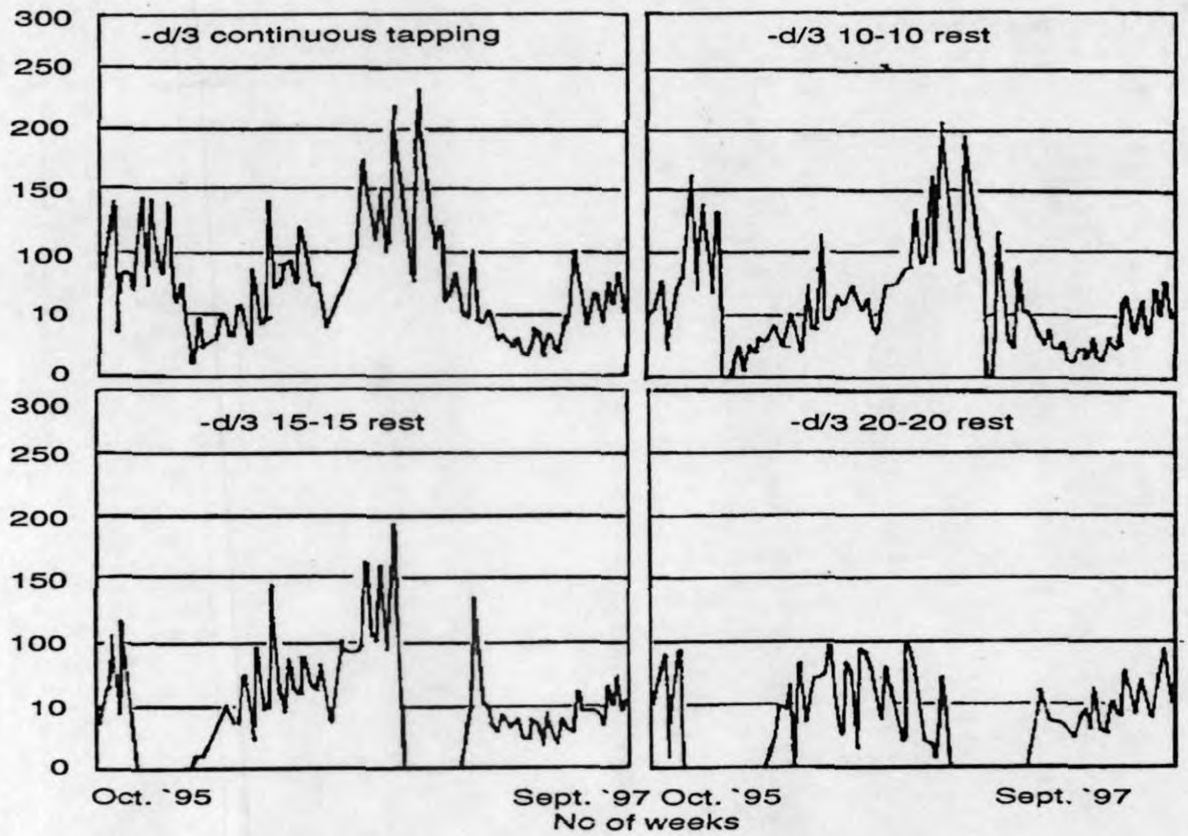

Fig. 3c. Mean yield pattern in d/3 tapping system at different temperature regimes

14th SMW (1st week of April), about 3 to 4 weeks more than that of the 15-15°C rest period. Yield is seen to be generally high at the beginning of tapping after the rest period, within a single week, accompanied by a high degree of decline to its average yielding position (Shuochang and Yagang, 1990). Differences in yield were more pronounced between the 10°C and the 15°C rest regimes.

During the experimental period, more than 50 per cent defoliation had occurred in the plantation by the 5th week (1st week of February) and fully defoliated by the 7th week, but significant yield reduction occurred only from the 9th week (February 4th week) till the 21st week (May 3rd week), when it was fully refoliated. A high increment in relative yield rate per week (gm/tap/unit tapping length) was observed during the low yielding weeks in between the 15th SMW to about the 20th SMW (April 2nd week to May 3rd week). This high increment may be due to the favourable environmental conditions with a high amount of daily sunshine duration (8 hours daily) and moderate to high rainfall during this period.

One of the important factors considered for the choice of optimum form of system of tapping with temperature rests, is the occurrence of TPD after a certain period. It is quite an established fact that latex flow is an abnormal physiological phenomenon induced by tapping in the ontogenesis of rubber trees (Sethuraj, 1988). Over exploitation by intensive tapping also sabotages the physiological balance between latex regeneration and flow, resulting in metabolic disorders. Hence, the 1/2S d/1 tapping system, though showing fairly good yield, is accountable for higher incidences of TPD (Chua, 1967).

The TPD scores definitely showed occurrences of partial TPD on a highly intensified tapping system. The occurrences of TPD were less in the ½ Sd/2 and ½ Sd/3 systems

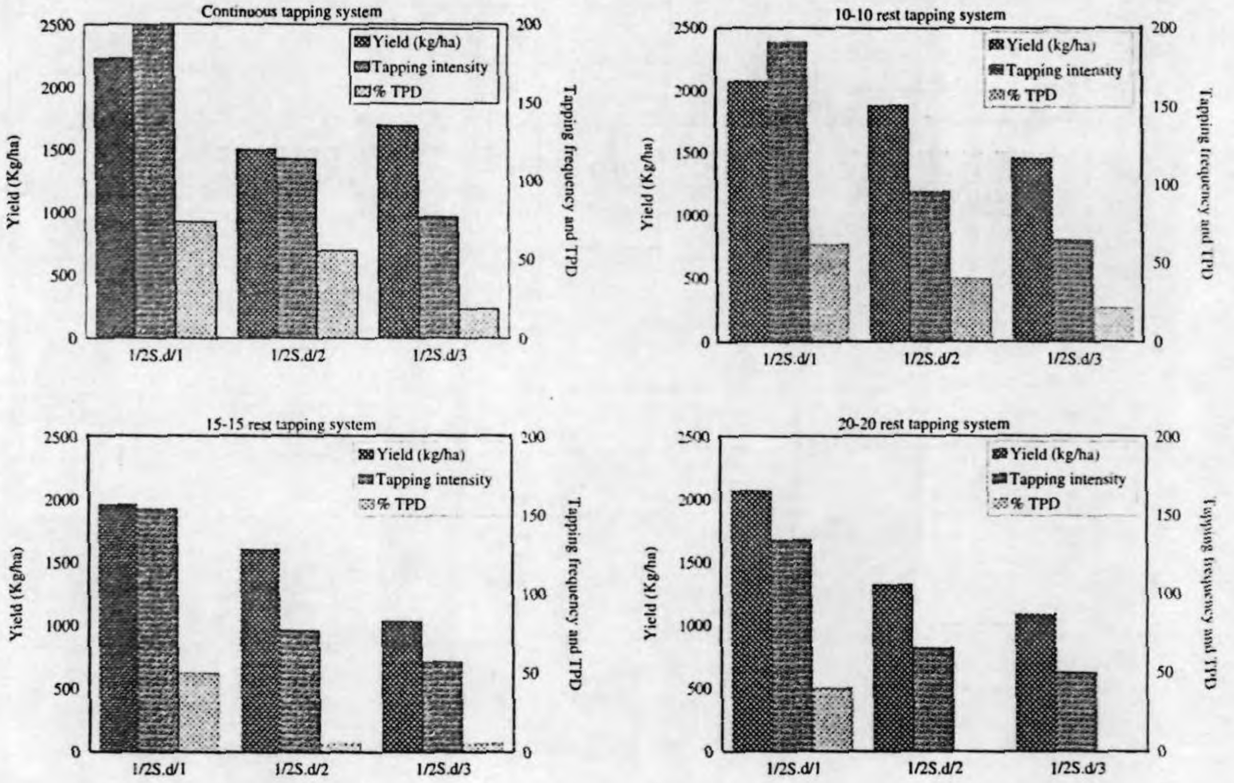

Fig. 4. Tapping intensity, yield and percentage of TPD of the different systems of tapping in combination with rests based on minimum temperature

of tapping, especially in the 15 and 20^{0}C regimes. However the ½ Sd/2 system with 15-15^{0}C regime gave the lowest level of dryness percentage (5%) in comparison with its corresponding yield (Fig 4). This particular combination also gave the highest yield in relation to its corresponding actual tapping intensity. Although the ½ Sd/2 system of 10-10^{0}C gave a high yield in comparison with low actual intensity, the occurrence of TPD was very high, which makes it less acceptable than that of the 15-15^{0}C rest. It is relevant to mention here that fluctuations of panel drying percentages at different seasons of the year on individual trees have been noticed. The experimental trees exhibited higher percentages of drying during the cold season but the percentage drying showed fewer occurrences during the other seasons; the drying seems to be persisting when the occurrence was above the 50 per cent value. This is because of the fatigue based reversible tendencies in TPD syndrome which were quite frequently observed in most of the highly exploited trees (Jacob et. al., 1994). The phenomenon observed here, remains localized and initially may not lead to total TPD, for which the original causes have been particularly linked to over intense tapping and also to specific ecoclimatic conditions (Chrestin et. al., 1985).

It is quite evident from the study that, in the existing environment of the region, periods of tapping rests are inevitable in order to prevent any deleterious effect to the plant. Further experimentation on a large scale basis can be followed considering the importance of the d/2 system with 15-15^{0}C tapping rest periods (Fig 4). Occurrences in TPD symptoms were more during the winter period compared to the other seasons. Thus, an ideal approach would be to evaluate conditions with less intensified tapping during the late dripping winter season.

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