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Research Article

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Long term yield response of low frequency tapping and yield stimulation in clone RRII 105

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Abstract

An experiment was laid out in the Experimental Farm Unit of Rubber Research Institute of India located at Kottayam, Kerala (9°32'N; 76°36'E) to compare the long term (fifteen years) yield response of clone RRII 105 to low frequency tapping with varying levels of yield stimulation. Reduction in cost of production by adopting low frequency tapping with stimulation (ethephon) is one of the approach to make rubber cost effective. Cumulative dry rubber yield over fifteen years under d3, d4 and d6 frequencies with stimulation is comparable to unstimulated alternate daily tapping (d2). There was no reduction in yield in the renewed bark (BI-1) compared to virgin panel (BO-1) and high yield was obtained in BO-2 panel under d3 and d4 frequencies of tapping. Total tapping days during the study period for d2, d3, d4 and d6 frequencies of tapping days were 2161, 1470, 1105 and 766 days, respectively. Thus, by adopting d3, d4 and d6 frequencies of tapping, requirement of tapper was reduced by 32, 49 and 65 per cent respectively, compared to alternate daily tapping. Benefits of adopting LFT are long term sustainable yield and extended period of tapping on the same panel leading to longer economic life of the trees. Adoption of LFT is also expected to reduce the impact of the scarcity of skilled tappers in rubber plantation sector.

Keywords: Ethephon, *Hevea brasiliensis*, low frequency tapping, stimulation, yield

Introduction

Among the rubber producing countries, India ranks the first position in natural rubber (NR) productivity. In India, cost of production is also high due to undulating topography, agroclimate and other cultural practices. Cost of tapping accounts for a major part in the cost of production of natural rubber. In some countries, tapping alone accounts for more than 70 per cent of the cost of production of NR. India and other rubber producing countries are facing severe shortage of skilled tappers. In general, tapping wages in the smallholder sector are lower than the wages paid to the other agricultural sector (Mohanakumar and Chandy, 2009). The failure of tapping labour market to attract younger generation to tapping will aggravate the situation in the years ahead (George, 2012). Under these circumstances, grower has to pay more wages to attract the tapper to tap their trees or leave it untapped due to unavailability of skilled tapper. Increasing labour productivity by adopting low frequency tapping with mild yield stimulation (ethephon) is one of the approaches to reduce the cost of production and to overcome tapper shortage (Gohet *et al.*, 1991; Vijayakumar *et al.*, 2001; Karunaichamy *et al.*, 2001). Earlier reports also had shown good yield response of rubber clones to less labour input tapping systems with ethephon application (Sivakumaran and Chong, 1994; Thanh *et al.*, 1996).

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Use of ethephon under low frequency tapping is recommended for high yielding clones like RRII 105. There is no adverse effect by judicious yield stimulation on high yielding clones tapped under low frequency tapping (Karunaichamy *et al.*, 2001; Vijayakumar *et al.*, 2002; Karunaichamy *et al.*, 2012). In India, significant and sustainable yield increase was achieved in RRII 105 under low frequencies of tapping by judicious application of ethephon from the opening onwards without any harmful effect in the long run (Vijayakumar *et al.*, 2001, Karunaichamy *et al.*, 2001; Rajagopal *et al.*, 2004; Karunaichamy *et al.*, 2012; Thomas *et al.*, 2008).

The objective of this study was to compare the long term yield response of clone RRII 105 under different frequencies of tapping and stimulation.

Materials and methods

The experiment was laid out in the Experimental Farm Unit of Rubber Research institute of India located at Kottayam, Kerala (9°32'N; 76°36'E). Average stand per hectare was 450 trees. There were ten treatments comprising d2 (without stimulation as control), d3, d4 and d6 frequencies of tapping with different frequencies of stimulation. The treatment details are given below as per the new tapping notations (Vijayakumar *et al.*, 2009).

T1 - S/2 d2 6d/7 (control)

T2 - S/2 d3 6d/7. ET2.5% Pa1(1.5) 3/y*

T3 - S/2 d3 6d/7. ET2.5% Pa1(1.5) 4/y*

T4 - S/2 d3 6d/7. ET2.5% Pa1(1.5) 5/y*

T5 - S/2 d4 6d/7. ET2.5% Pa1(1.5) 5/y*

T6 - S/2 d4 6d/7. ET2.5% Pa1(1.5) 7/y*

T7 - S/2 d4 6d/7. ET2.5% Pa1(1.5) 9/y*

T8 - S/2 d4 6d/7. ET2.5% Pa1(1.5) 10/y*

T9 - S/2 d4 6d/7. ET2.5% Pa1(1.5) 12/y

T10 - S/2 d4 6d/7. ET2.5% Pa1(1.5) 15/y*

The experimental design was RBD with five replications comprising 25 trees per replication. Yield stimulation was done by applying ethephon @ 2.5% on the panel. All the cultural practices were as per the standard package of practices (Rubber Board, 2010). Trees were rainguarded and tapped throughout the year without giving annual rest. Yield from each replicate was recorded as latex and scrap separately on all the tapping days. Dry rubber yield was calculated by converting latex weight proportionate to the drc, and scrap weight based on 60 per cent drc. Tapping panel dryness (TPD) was recorded as complete non-yielding status of tapping cut. Data on yield and other parameters are presented for the period from April 1997 to March 2012.

Results and discussion

Annual dry rubber yield (kg ha^{-1}) for fifteen years (1997 – 2012) under different tapping frequencies and varying levels of stimulation are statistically analyzed and presented in Figs. 1 & 2. During first and second year of tapping, yield under d3 and d4 frequencies of tapping were comparable to that of d2 frequency of tapping. Under d6 frequency of tapping, low yield was noticed during the initial years. High frequencies of stimulation are essential for improving stability of latex in the initial years (Koshy, 1997). The low yield under weekly frequency of tapping during the initial years was nullified by applying ethephon at fortnightly intervals (Karunaichamy *et al.*, 2001). In some of the earlier reports response was not good under

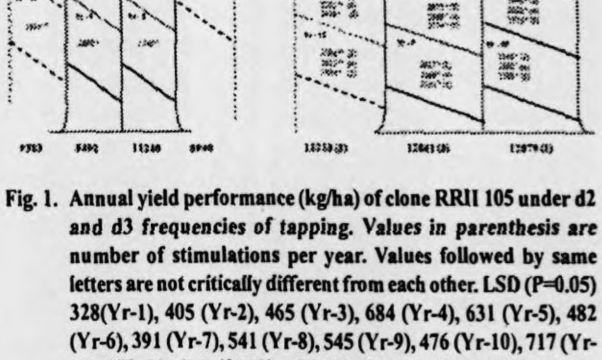

Fig. 1. Annual yield performance (kg/ha) of clone RRII 105 under d2 and d3 frequencies of tapping. Values in parenthesis are number of stimulations per year. Values followed by same letters are not critically different from each other. LSD (P=0.05) 328(Yr-1), 405 (Yr-2), 465 (Yr-3), 684 (Yr-4), 631 (Yr-5), 482 (Yr-6), 391 (Yr-7), 541 (Yr-8), 545 (Yr-9), 476 (Yr-10), 717 (Yr-11), 372 (Yr-12), 493 (Yr-13), 521 (Yr-14), 483 (Yr-15).

weekly tapping (Gohet *et al.*, 1991; Sivakumaran *et al.*, 1993; Vijayakumar *et al.*, 2002). In the present study, BO-2 panel was opened in the 5th year under d2, 6th year under d3, 7th year under d4 frequencies and 8th year under d6 frequency with high yield compared to last year tapping on BO-1 panel (Figs.1 & 2). During the panel change, very high yield was obtained due to extension of drainage area on the panel. It is evident that there was resurgence in yield during the first year of tapping in panel BO-2 in all frequencies after the panel changed over from BO-1. Similar results of higher yield after panel change (BO-1) was reported earlier in other clones and in clone RRII 105 (Thanh *et al.*, 1998; Rajagopal *et al.*, 2004; 2005; Karunaichamy *et al.*, 2008). Low yield noticed during last year of tapping on BO-1 and BO-2 panel may be associated with proximity of tapping cut to bud union.

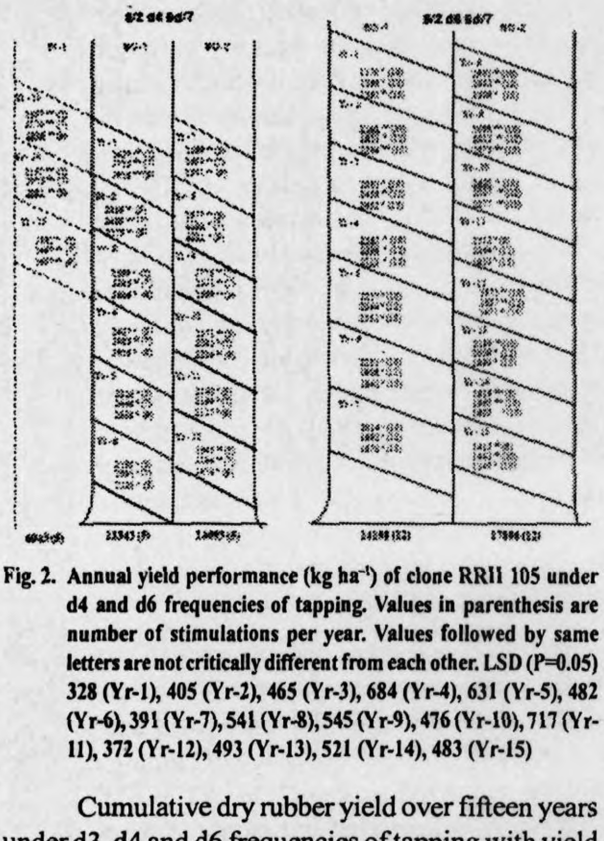

Fig. 2. Annual yield performance (kg ha^{-1}) of clone RRII 105 under d4 and d6 frequencies of tapping. Values in parenthesis are number of stimulations per year. Values followed by same letters are not critically different from each other. LSD (P=0.05) 328 (Yr-1), 405 (Yr-2), 465 (Yr-3), 684 (Yr-4), 631 (Yr-5), 482 (Yr-6), 391 (Yr-7), 541 (Yr-8), 545 (Yr-9), 476 (Yr-10), 717 (Yr-11), 372 (Yr-12), 493 (Yr-13), 521 (Yr-14), 483 (Yr-15)

Cumulative dry rubber yield over fifteen years under d3, d4 and d6 frequencies of tapping with yield stimulation is comparable to unstimulated alternate daily tapping (Fig. 3). The cumulative dry rubber yield obtained with d3 (3 stim/y), d4 (5 stim/y) and d6 (12 stim/y) systems were 104%, 99% and 92% of d2 frequency of tapping (Fig. 3). Reports from

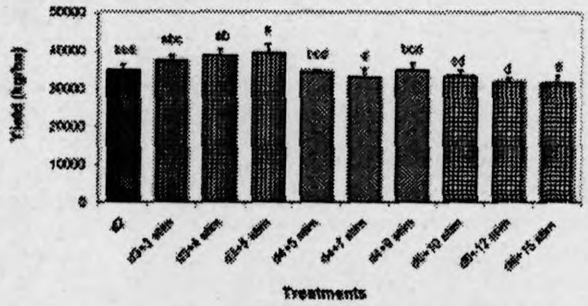

Fig. 3. Cumulative yield (kg ha^{-1}) of clone RRII 105 under different tapping frequencies over fifteen years of tapping. Values followed by same letters are not critically different from each other. Vertical bar represent SE; (n=15)

Malaysia on Low Intensity Tapping System (LITS) indicated that it would be profitable if break-even yield of 90% of that of alternate daily tapping are obtained (Nayagam *et al.*, 1986). Cumulative yield under d3, d4 and d6 frequencies of tapping resulted in 51%, 59% and 69% yield increase in BO-1 panel and 13%, 30% and 58% yield increased in BO-2 panel over d2 system of tapping (Fig. 4). Mean annual yield under third daily tapping, fourth daily tapping and weekly frequencies were comparable

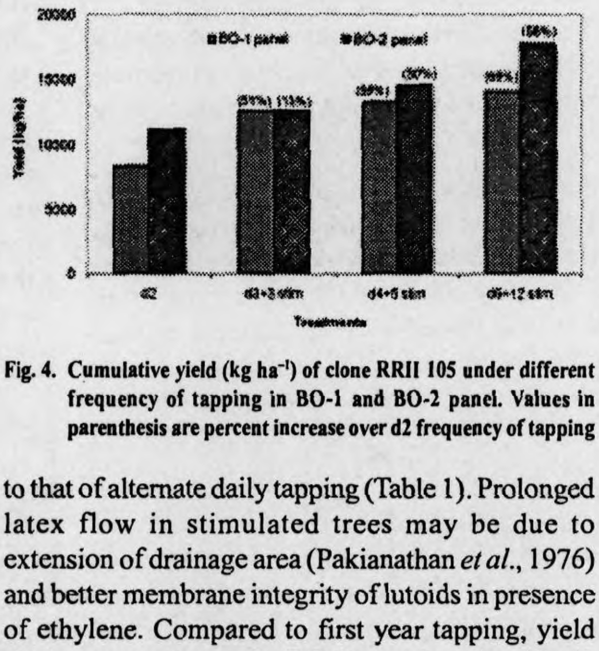

Fig. 4. Cumulative yield (kg ha^{-1}) of clone RRII 105 under different frequency of tapping in BO-1 and BO-2 panel. Values in parenthesis are percent increase over d2 frequency of tapping

to that of alternate daily tapping (Table 1). Prolonged latex flow in stimulated trees may be due to extension of drainage area (Pakianathan *et al.*, 1976) and better membrane integrity of lutoids in presence of ethylene. Compared to first year tapping, yield during second year in BO-2 panel under d2, d3 (3 stim) and d4 (5 stim) frequencies of tapping was lower by 20%, 38%, 0.5% respectively (Figs. 1 & 2). Under d6 (12 stim) frequency of tapping, yield was increased by 5% during second year of BO-2 panel tapping.

Table 1. Mean yield (fifteen years) and other parameters of clone RRII 105 tapped under different frequencies of tapping and stimulation.

Treatments	Yield (kg ha^{-1})	kg tree^{-1}	No. of taps	kg tap^{-1} per 400 trees
T1- S/2 d2 6d/7 (Control)	2331 ^{bcd}	7.1 ^{a}	144	19.8 ^{e}
T2 - S/2 d3 6d/7. ET 2.5% 3/y*	2505 ^{abc}	6.4 ^{bc}	98	26.3 ^{d}
T3 - S/2 d3 6d/7. ET 2.5% 4/y*	2575 ^{ab}	6.7 ^{ab}	98	27.3 ^{d}
T4 - S/2 d3 6d/7. ET 2.5% 5/y*	2633 ^{a}	7.2 ^{a}	98	29.5 ^{cd}
T5 - S/2 d4 6d/7. ET 2.5% 5/y*	2299 ^{bcd}	6.0 ^{cd}	74	32.2 ^{bc}
T6 - S/2 d4 6d/7. ET 2.5% 7/y*	2212 ^{d}	6.0 ^{cd}	74	32.4 ^{bc}
T7 - S/2 d4 6d/7. ET 2.5% 9/y*	2336 ^{bcd}	6.2 ^{bc}	74	33.6 ^{b}
T8 - S/2 d6 6d/7. ET 2.5% 10/y*	2236 ^{cd}	5.5 ^{bc}	51	42.8 ^{a}
T9 - S/2 d6 6d/7. ET 2.5% 12/y(m)	2134 ^{d}	5.3 ^{e}	51	41.4 ^{a}
T10 - S/2 d6 6d/7. ET 2.5% 15/y*	2115 ^{d}	5.2 ^{e}	51	40.2 ^{a}
LSD (P=0.05)	**281**	**0.6**	-	**3.3**

Within the column, values followed by same letters are not critically different from each other

Mean annual tapping days during the study period under d2, d3, d4 and d6 frequencies of tapping were 144, 98, and 74 and 51 days, respectively. Thus by adopting d3, d4 and d6 frequencies of tapping, requirement of tapper can be reduced by 32%, 49% and 65% respectively, compared to alternate daily tapping. Mean dry rubber yield (kg tap^{-1} per 400 trees) and yield per tree are presented in Table 1. The increase in yield per tap with reduced tapping frequency can be due to the fact that trees had long intervals between successive tapping days which allows better regeneration (Sivakumaran *et al.*, 1984). The use of ethephon under low frequency tapping at recommended level is only to compensate the potential loss of yield through reduced tapping days.

Mean monthly variation of yield (g t^{-1} t^{-1}) over fifteen years under d2, d3, d4 and d6 frequencies with 0, 3, 5 and 12 stimulations per year are presented in Fig.5. Mean yield of 103.9 g tree^{-1} tap^{-1} was obtained in trees tapped under d6 frequency. Trees showed the lowest yield (49.1 g t^{-1} t^{-1}) under d2

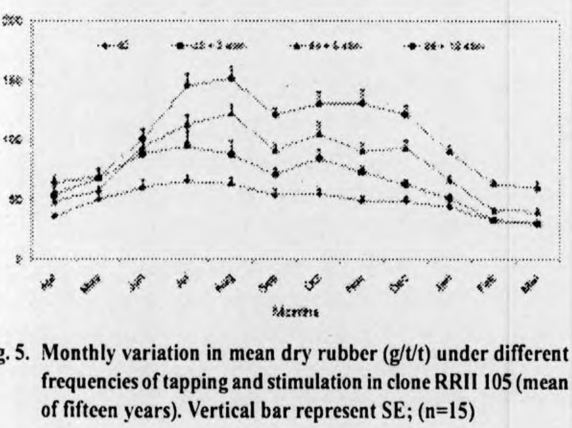

Fig. 5. Monthly variation in mean dry rubber (g/t/t) under different frequencies of tapping and stimulation in clone RRII 105 (mean of fifteen years). Vertical bar represent SE; (n=15)

frequency of tapping. Similar trend was observed when the trees were tapped under different frequencies of tapping (d2, d3, d4 and d6) in BO-1 and BO-2 panels tapping (Karunaichamy *et al.*, 2008; Karunaichamy *et al.*, 2012). Higher per tap yield under low frequency tapping indicates the need for delayed and additional collection to reduce field coagulum. However, data on monthly variation shows that second collection need not be done in all months (Fig.5). Ethephon delays plug formation on tip of latex vessels leading to prolonged latex flow resulting in higher yield (Kush *et al.*, 1990). Increased alkalanisation and increased chitinase activity leads to increased rate and duration of latex flow (Koshy, 1997; Thanh *et al.*, 1998). The rubber synthesizing capacity of the panel was less adversely affected by LFT with appropriate yield stimulation than that of trees tapped under d2 frequency of tapping (Sivakumaran *et al.*, 1984). Our results show that low frequency tapping can be successfully carried out in India. Success of LFT warrants regular tapping, which is made possible by proper rainguarding of the tapping panels, a practice successfully followed in India.

There are several other benefits under LFT such as the low incidence of tapping panel dryness, extended period of tapping on the same panel and increase in tree girth than d2 frequency of tapping. Conversion from high frequency (d2) to LFT would increase the daily earnings of the tapper if over poundage system of incentive is practiced. Certainly this will lead to substantial improvement in the standard of living of tapper. In India, low frequency tapping systems have been successfully extended to many estates and medium holdings in India covering different agroclimatic conditions. Demonstration plot on LFT (d3) have been initiated in small holdings. A major policy option suggested to address tapping labour shortage issue is pooling of available tappers under the RPS network with an assurance of regular employment which is a potential precursor to the adoption of LFT and reduction in the tapper requirement (George, 2012).

Conclusions

Present study clearly showed that tapping under d3, d4 and d6 along with appropriate stimulation can result in comparable production to that of alternate daily tapping. Sustainable yield can be achieved under LFT with yield stimulation and the grower can benefit from reduction in cost of production and increased economic life of rubber trees. Adoption of LFT is also expected to reduce the impact of scarcity of skilled tapper in rubber plantation sector. It is assumed that, if 50% of small holdings convert from d2 to d3 frequency, the current skilled tapper shortage in India can be resolved. Practice of fixing rainguarding during monsoon will help to ensure regular tapping and success of LFT.

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