Original Research Article

EFFECT OF EARLY UPWARD TAPPING ON RUBBER PRODUCTIVITY OF CLONE PB 260 OF THE FAST METABOLIC ACTIVITY CLASS

Abstract

In order to evaluate the effect of early upward tapping on rubber productivity of rubber trees and to determine its proportion relative to downward tapping, a study was conducted at SAPH Divo on the PB 260 clone of the fast metabolic activity class. The experimental set-up was a Fisher block with seven treatments and three replications. Tapping was carried out in d3 with 6 stimulations. Three upward tapping times at 6, 7 and 8 years, each coupled with two concentrations of the stimulating paste 2.5 and 5% of Ethephon and a downwardly tapped control stimulated with 5% of Ethephon were tested. The data collected were for rubber production, isodiametric growth, tapping panel dryness susceptibility and tree physiological profile. The results showed that the different treatments tapped in upward at 6, 7 and 8 years of age significantly improved the productivity of the PB 260 clone relative to the control by descending for nine years. All treatments combined, rubber productivity (4723 kg.ha-1.yr^{-1}) and radial vegetative growth (3.8 cm.yr^{-1}) were good. The gain in rubber productivity of the early upward tapping compared to the downward tapping was 42%. The tapping panel dryness rate was low at 2.6% and the physiological profile of the trees was well balanced. Our results suggest that PB 260, and therefore metabolically active clones, can be tapped in early upward tapping, especially at 6 years of age.

Key words: tapping, upward, early, productivity

1. INTRODUCTION

Hevea brasiliensis Muell Arg. (Euphorbiaceae) is a tropical plant species cultivated for its latex, used in innumerable fields (tires, medicine, etc...). The exploitation of rubber trees can last more than thirty years [1, 2]. In Côte d'Ivoire, this thirty-year period of latex harvesting is carried out in two distinct phases. The first phase consists of alternately exploiting the two low panels (BO) in descending tapping for nine years [3]. This phase is immediately followed in the tenth year by the second phase, which consists of exploiting the high panel (HO) in quarter spiral for four years [4]. At the end of this first series of four years of upward tapping, which ends in the 13th year of tapping of the rubber tree, a second series of downward tapping (14th and 15th years) is carried out. This is followed by the second series of four years of upward tapping completing the tapping on virgin bark.

This current tapping panel management scheme [4] in the African rubber region is effective since these two phases are characterized by an increasing gradient of rubber productivity [4, 5]. Despite this increasing productivity, non-industrial rubber farmers expect more. This is especially true since this environment is characterized by, among other weaknesses, a very high consumption of bark [5], which further complicates the management of their bark capital, according to the tapping panel management scheme of Gohet *et al* [4]. Where possible, they want to have latex harvesting systems that provide a higher return on investment in a short period of time [3]. This aspiration can only be met by adjusting the downward tapping time. In particular, by shortening it and replacing the delay gap with upward tapping, which is much more productive and whose yield is at least 25% higher than that of downward tapping [5]. However, the proportion of this improvement in rubber productivity due to upward tapping is not known, especially in relation to latex harvesting technology and clone metabolism. For it is known that latex harvesting technologies giving high rubber production induce dry notching and exacerbate trees, reducing radial vegetative growth and creating physiological disorder.

Thus, our study aims to evaluate the productivity of rubber trees and to determine the proportion of productivity differential of early upward tapping versus down tapping of clone PB 260 during four years of latex harvesting. Specifically, to determine the effect of early upward tapping on:

- rubber productivity ;

- radial vegetative growth;

- the rate of trees affected by tapping panel dryness;

- physiological profile.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Study site

The experiment was conducted in the rubber plots of the Société Africaine de Plantation d'Hévéa (SAPH) in Divo, from October 2012 to December 2016. The plots of this company are located in Divo in east-central Côte d'Ivoire, between 5°49'north latitude and 5°22' west longitude. The department of Divo is subject to a tropical and rainy climate characterized by an average temperature at Divo of 25.3°C and annual rainfall of 1388 mm.

2.1.2 Plant material

The plant material used consists of *Hevea brasiliensis* clone PB 260. This clone is of the fast metabolic activity class and is one of the most planted clones in Côte d'Ivoire, as it is considered a high producer. This clone originates from Malaysia and is a genetic cross of PB 5/51 × PB 49 [6].

2.2. Methods

2.2.1. Experimental setup

Trees of clone PB 260 were planted in a straight line at a density of 510 trees per hectare (7m x 2.8m). The experimental design used is a Fisher block, composed of 7 treatments repeated three times with 25 trees per elementary plot. These different plots were bled when 50% of the selected trees had a circumference of 50 cm at 1 m above the ground.

2.2.2. Treatment

Trees in the elementary plots were opened in October 2012 in upward tapping at 1.25 m above the ground on panel A (HO-1), in the 6th, 7th, 8th year after five years of downward tapping on panels A (BO-1) and B (BO-2) (Table I).

Table I: treatments applied to clone PB 260 in October 2012

N°	Treatments	abbreviations	Designation
1	S/4 U d3 6d/7 ET 5% Pa 1(1) 6/Y **(6 years)** :	(6 years, 5%ET)	Quarter-spiral tapping at 6 years of age every three days, six working days out of seven; stimulated with 5% concentrated ethephon at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations performed per year
2	S/4 U d3 6d/7 ET 2.5% Pa 1(1) 6/Y **(6 years)** :	(6 years, 2.5%ET)	Quarter-spiral tapping at 6 years of age every three days, six working days out of seven; stimulated with 2.5% ethephon concentrate at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations performed per year
3	S/4 U d3 6d/7 ET 5% Pa 1(1) 6/Y **(7 years)** :	(7 years, 5%ET)	Quarter-spiral tapping at 7 years of age every three days, six working days out of seven; stimulated with 5% concentrated ethephon at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations performed per year
4	S/4 U d3 6d/7 ET 2.5% Pa 1(1) 6/Y **(7 years)** :	(7 years, 2.5%ET)	Quarter-spiral tapping at 7 years of age every three days, six working days out of seven; stimulated with 2.5% ethephon concentrate at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations performed per year
5	S/4 U d3 6d/7 ET 5% Pa 1(1) 6/Y **(8 years)** :	(8 years, 5%ET)	Quarter-spiral tapping at 8 years of age every three days, six working days out of seven; stimulated with 5% ethephon concentrate at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations per year
6	S/4 U d3 6d/7 ET 2.5% Pa 1(1) 6/Y **(8 years)** :	(8 years, 2.5%ET)	Quarter-spiral tapping at 8 years of age every three days, six working days out of seven; stimulated with 2.5% ethephon concentrate at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations performed per year
7	S/2 d3 6d/7 ET 2.5% Pa 1(1) 6/Y (**control**):	(10 years, 5%ET)	Downward half-spiral tapping every three days, six working days out of seven; stimulated with ethephon concentrated at 5% at a rate of 1 g of stimulant on a 1 cm wide strip; 6 stimulations are practiced per year (upward tapping at 10 years with 5%ET)

2.2.3. Trial conduct and data collection

- **Production data**

Rubber production data were collected by tapping trees in the elemental plots in quarter spiral every 3 days (d3), with 6 annual stimulations (6/y). The stimulating paste is concentrated at 5 or 2.5% active ingredient which is chloro-2-ethyl phosphonic acid or Ethephon (ET5% Pa1(1) or (ET2, 5% Pa1(1). The collection lasted four years, alternating annually between tapping panels A (HO-1), B (HO-2), C (HO-3) and D (HO-4). Rubber production from each treatment was weighed every 4 weeks using a scale. Samples of fresh rubber were collected for each treatment to determine the Coefficient of Transformation (CT), which is the percentage of dry matter in a given rubber sample, which was used to calculate the production of dry rubber expressed in grams per tree per tapping (g t^{-1} t^{-1}) and in kilograms per hectare per year (kg ha^{-1} y^{-1}).

- **Radial vegetative growth**

At the beginning of the experiment, and then once a year in December, the circumference of the trunk of the trees was measured at 1.70 m from the ground with a tape measure. The average annual increase in circumference was determined by the following relationship:

$$Gi\ (cm\ year^{-1}) = Gn - G_{n-1}.\ (1)$$

Where **Gn** is the mean girth of trees in the year n and $\mathbf{G_{n-1}}$, the mean girth of trees in the year n-1.

- **Tapping panel dryness**

The quick measurement method of tapping panel dryness was done by visual assessment. The trees were scored on a 0- 6 scale based on the progress of tapping panel dryness (TPD). The percentage of trees completely dry (TPD) was determined by the following relation:

$$TPD\ (\%) = (n6 + DT) \times N^{-1}$$

With: **N**: Total number of trees; **DT**: Number of trees which tapping has been already stopped because of total tapping panel dryness (Dry Trees). **n6** : For each treatment, the percentage of trees completely dry

- **Physiological parameters**

Latex was collected for the realization of the latex micro diagnosis (LMD) in view of the physiological state of the trees studied through the dry extract rate (Ex.S) of the latex and the contents of sucrose (Sac), inorganic phosphorus (Pi) and thiol group of the latex. The dry extract content was determined according to the method described by Eschbach *et al*. [6], while the methods of Ashwel [7], Taussky and Shorr [8], Boyne, and Ellman [9] were used to determine the sucrose, inorganic phosphorus, and thiol group contents of latex, respectively. The MDL data were analysed based on the reference values established by Jacob et al. [10]. The results were expressed in millimoles per litre of latex (mmol l^{-1}) from the coefficients of the calibration ranges.

- **-Statistical Analysis**

The collected data were processed using XL-STAT statistical software. An analysis of variance was performed to determine the level of significance. The difference between the means was estimated by the NEWMAN-KEULS test at a threshold of 5%.

3. RESULTS

3.1. Rubber production

The average annual production at the tree and at the tapping stage was 111.0 g t^{-1} t^{-1}, all treatments combined (Table II). It varied significantly according to the treatment (84 to 130 g t^{-1} t^{-1}). The production of treatments 1 (6 years, ET5%;126 g t^{-1} t^{-1}), 2 (6 years, ET2.5%; 126 g t^{-1} t^{-1}) and 3 (7 years, ET5%;130 g t^{-1} t^{-1}) are statistically identical to each other and were significantly higher than those of the downwardly tapping control (10 years, ET5%; 84 g t^{-1} t^{-1}) and treatments 5 (8 years, ET5%; 90 g t^{-1} t^{-1}) and 6 (8 years, ET2.5%; 86 g t^{-1} t^{-1}).

Similarly, the average annual rubber yield expressed in kg.ha^{-1}.yr^{-1} for all treatments combined, under early upward tapping, was 4612 kg.ha^{-1}.yr^{-1} . It was influenced by the treatment and ranged from 3566 to 5239 kg.ha^{-1}.yr^{-1}. Treatments 1 (6 years, ET5%; 5488 kg.ha^{-1}.yr^{-1}), 2 (6 years, ET2.5%; 5373 kg.ha^{-1}.yr^{-1}) and 3 (7 years, ET5%; 5354 kg.ha^{-1}.yr^{-1}) had statistically identical and higher yields than the other treatments. However, those of treatments 5 (8 years, ET5%; 3916 kg.ha^{-1}.yr^{-1}), 6 (8 years; ET2.5%; 3665 kg.ha^{-1}.yr^{-1}) and the control (10 years, ET5%; 3335 kg.ha^{-1}.yr^{-1}) were significantly lower by the same amount.

The concentration of the stimulating paste did not significantly influence rubber production.

The overall average productivity gains for all tapped treatments, in early upward, was 42% higher than that of the control.

In general, the production was of a good level and the rubber trees were more productive in the 6- and 7-year-old tapped designs with gains of more than 50%.

Table II: Average dry rubber production of clone PB260, subjected to early upward tapping.

N°	Treatments	Average rubber production			
		g.t^{-1}.t^{-1}	**Gain (%)**	**kg.ha^{-1}.yr^{-1}**	**Gain (%)**
1	S/4U d3 6d/7 ET5% Pa1(1) 6/y (6 years)	126 ± 15,5 a	50	5488 ± 64,3 a	65
2	S/4U d3 6d/7 ET2.5% Pa1(1) 6/y (6 years)	126 ± 27,4 a	50	5373 ± 11,4 a	61
3	S/4U d3 6d/7 ET5% Pa1(1) 6/y (7 years)	130 ± 14,7 a	55	5354 ± 58,9 a	61
4	S/4U d3 6d/7 ET2.5% Pa1(1) 6/y (7 years)	108 ± 19,6 ab	29	4540± 82,3 ab	36
5	S/4U d3 6d/7 ET5% Pa1(1) 6/y (8 years)	90 ± 7,3 b	7	3916 ± 28,6 b	17
6	S/4U d3 6d/7 ET2.5% Pa1(1) 6/y (8 years)	86 ± 7,0 b	2	3665 ± 30,0 b	10
7	S/2 d3 6d/7 ET5% Pa1(1) 6/y (Control)	84 ± 6,8 b	0	3335 ± 27,9 b	0
	Overall average (early upward tapping times)	**111 ± 17,6**	33	**4723 ± 73,3**	42

Within a column, the means assigned the same letters are not significantly different (Newman keuls 5%).

3.2. Radial vegetative growth

The average annual increase in circumference presented in Figure 1 shows that the delay in upward tapping had a significant effect on the radial vegetative growth of the trees with an overall average of 3.8 $cm.year^{-1}$. The average annual increments are globally of a good level with a variation ranging from 3.5 to 4.4 $cm.year^{-1}$. The highest average annual increase in girth was obtained with treatment 5 (8 years, 2.5% ET; 4.4 $cm.year^{-1}$) tapped in reverse at 8 years with a concentration of 2.5% Ethephon. In addition, for the same year of upward tapping, the average annual increase in girth of trees that received a stimulating paste with a concentration of 2.5% Ethephon was greater than those that received a stimulating paste with a concentration of 5% Ethephon.

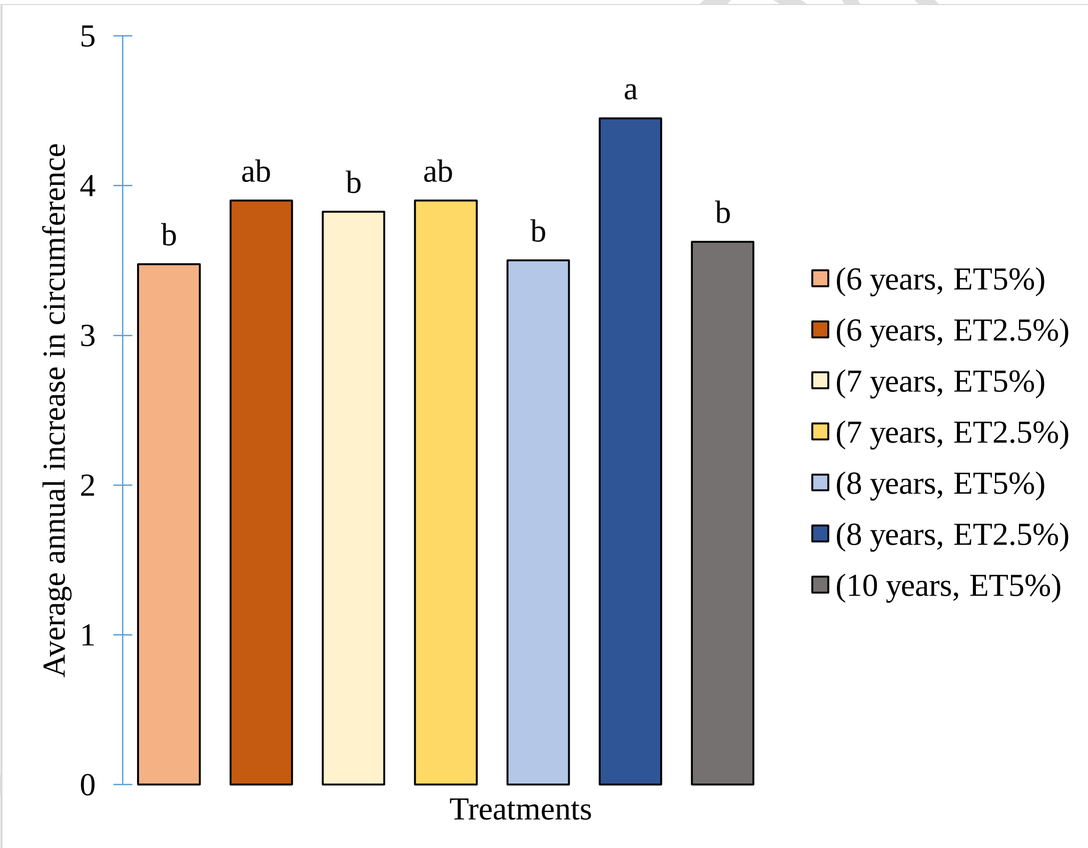

Figure 1: Average annual girth increase during four years of upward tapping of clone PB 260

3.3. Tapping Panel Dryness

The rate of tapping panel dryness for all treatments is presented in Figure 2. The annual average tapping panel dryness rate for all treatments was 2.6%. This rate was low and significantly influenced by treatment. Treatments 1 (6 years, ET5%; 0%), 2 (6 years, ET2.5%; 0%) and 6 (8 years, ET2.5%; 0.3%) yielded nearly zero annual mean rates. The rate of dry trees in the control treatment (10 years, ET5%; 7.75%) was significantly greater than in the other treatments. For the same year of upward tapping, at 6, 7, or 8 years, the designs that received the 5% Ethephon yielded more trees with dry notches.

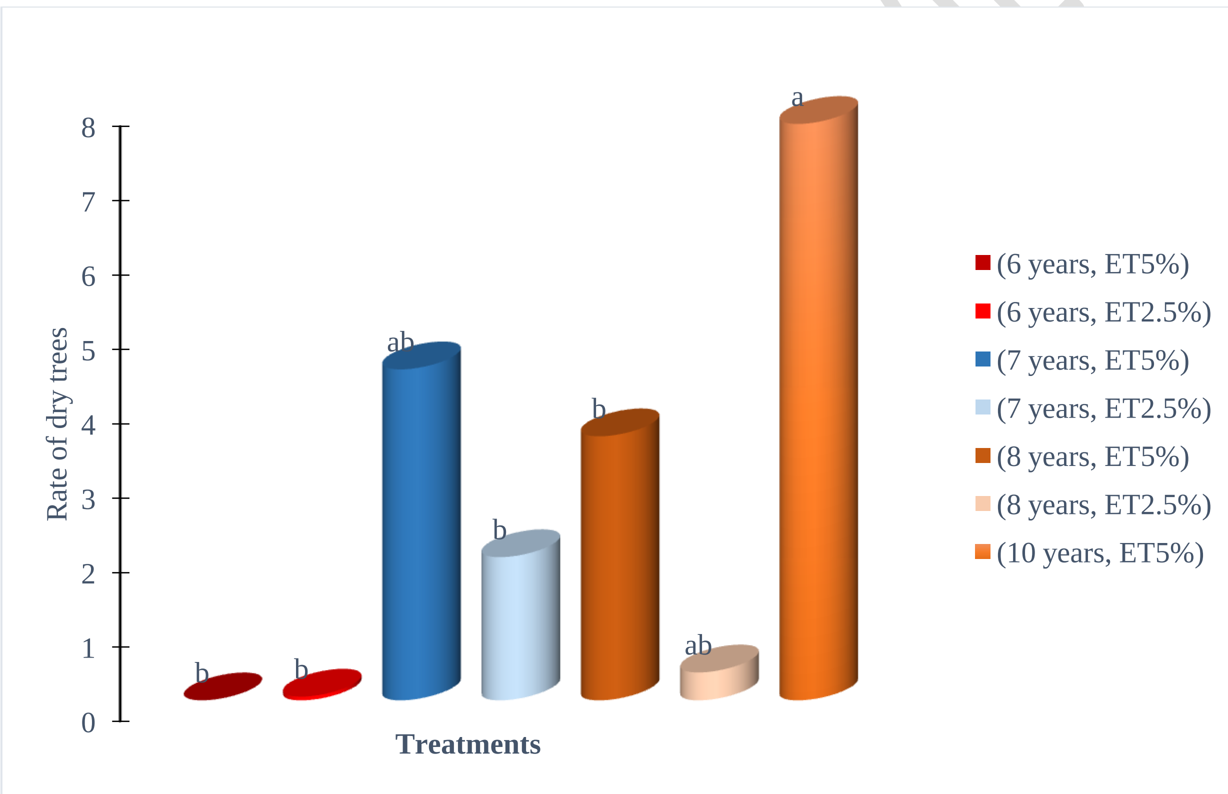

Figure 2: Average annual rate of trees with tapping panel dryness during four years of upward tapping

3.4. Physiological profile

The analysis of the dry extract rate shows that both at the beginning and at the end of the experiment, all the trees had very high latex dry extract rates (> 43, reference value; Table III). The average annual rate for all treatments combined was 46.6% at the beginning and 59.1% at the end of the experiment. At the beginning of the experiment, the dry rubber content varied statistically according to the treatment and fluctuated from 43 to 54.2%. The dry rubber content of treatments 3 (7 years, ET5%; 54%) and 4 (7 years, ET2.5%; 50%) was significantly higher than that of treatments 2 (6 years, ET5%; 45%), 5 (8 years, ET5%; 44%), 6 (8 years, ET2.5%; 43%) and 7 (control, 10 years ET5%; 43%). At the end of the trial, the rates all increased to an overall average of 59% and the different treatments had no significant effect on the dry extract rate.

At the beginning of the experiment, the average annual sucrose content of the latex, all treatments combined, was very low (2.4 $mmol.l^{-1}$) and did not vary relative to the treatment. At the end of the trial, there was an increase in content reaching 7.7 $mmol.l^{-1}$, which is an average content and consistent with that of an active metabolism clone. At the beginning of the trial, the averages per treatment were all the same, while at the end of the experiment the sucrose contents of the latex were influenced by the time of upward tapping. They increased, whatever the treatment. The highest contents were obtained from treatments 2 (6 years, ET2.5%; 9.8 $mmol.l^{-1}$) and 5 (8 years, ET5%; 10.4 $mmol.l^{-1}$) and the lowest from treatments 7 (10 years, ET5%; 5.2 $mmol.l^{-1}$) and 1 (6 years, ET5%; 5.1 $mmol.l^{-1}$).

The mean annual inorganic phosphorus content of the latex was average at the beginning and high at the end of the trial, with means for all treatments combined of 15.5 $mmol.l^{-1}$ and 24.3 $mmol.l^{-1}$ respectively. The Pi content of the latex of the different treatments was statistically different according to the treatment at the beginning and at the end of the trial. At the beginning of the trial, the Pi content of the latex of the control, tapped in reverse at 10 years (18 $mmol.l^{-1}$) and of treatments 5 (8 years, ET5%; 19 $mmol.l^{-1}$) and 6 (8 years, ET2.5%; 23.6 $mmol.l^{-1}$) were significantly equivalent and higher than those of the other treatments while that of treatment 2 (6 years, ET5%; 6.3 $mmol.l^{-1}$) was significantly lower. At the end of the trial, the contents were mostly high with contents ranging from 18.8 to 31.5 $mmol.l^{-1}$, giving significantly higher and identical values between them, obtained in treatments 1, 2, 3, 4 and 7.

The content of thiol compounds in the latex of all treatments is very low at the beginning of the trial (0.5 $mmol.l^{-1}$) and then becomes high at the end (0.8 $mmol.l^{-1}$) of the trial. All treatments, regardless of the period, gave statistically different levels. However, the trees opened at six years of age had the highest levels of SH-R at the beginning and at the end of the trial.

Table III: Physiological parameters of latex from trees tapped in upward during four years

N°	Treatments	DRC (%)		Suc (mmol.l^{-1})		Pi (mmol.l^{-1})		R-SH (mmol.l^{-1})	
		Begin	End	Begin	End	Begin	End	Begin	End
1	S/4 U d3 6d/7 ET5% Pa 1(1) 6/y (6 years)	47 ±3,0 ab	58 ±2,6 a	2,4 ± 1,2 a	5,1 ± 1,1 b	6,3 ± 2,3 c	31,5 ± 6,2 a	0,76 ±0,6a	1,35 ± 0,2 a
2	S/4 U d3 6d/7 ET2.5% Pa 1(1) 6/y (6 years)	45 ±3,3b	59 ± 2,8 a	2,8 ± 1,9 a	9,8 ± 3,2 a	14,1 ± 3,8 b	28 ± 6,01 a	0,56 ± 0,2 ab	0,95 ± 0,2 a
3	S/4 U d3 6d/7 ET5% Pa 1(1) 6/y (7 years)	54±4,2 a	56 ± 2,7a	2,8 ± 1,8 a	7,3 ±2,6 ab	15,3 ± 4,1 b	21,8 ± 3,2 ab	0,52 ± 0,6 ab	0,64 ± 0,2 ab
4	S/4 U d3 6d/7 ET2.5% Pa 1(1) 6/y (7 years)	50 ±3,7 a	60 ± 2,6a	3,6 ± 2,1 a	8,3 ± 2,8 ab	13 ± 3,2 b	22,9 ± 3,4 ab	0,63 ± 0,8 ab	0,64 ± 0,2 ab
5	S/4 U d3 6d/7 ET5% Pa 1(1) 6/y (8 years)	44 ±3,5b	62 ± 2,7a	1,6 ± 1,2 a	10,4 ± 3,7a	19 ± 4,2 ab	19,8 ± 4,3 b	0,54 ± 0,3ab	0,66 ± 0,2 ab
6	S/4 U d3 6d/7 ET2.5% Pa 1(1) 6/y (8 years)	43 ±3,05b	59 ± 2,5a	1,9 ± 1,4 a	8 ±2,6 ab	23,6 ± 3,7 a	18,8 ± 4,1 b	0,59 ± 0,2 ab	0,59 ± 0,2 b
7	S/2 d3 6d/7 ET5% Pa 1(1) 6/y (Control, 10 years)	43 ±3,01 b	60 ±2,3 a	1,5 ± 0,7 a	5,2± 1,1 b	18 ± 4,1 a	27 ± 5,9 a	0,31 ± 0,2 b	0,66 ± 0,2 ab
	General averages	**47 ±3,3 a**	**59 ±2,2 a**	**2,5±1,2b**	**8,1±3,1a**	**15,2±3,8 b**	**26,9±3,4 a**	**0,6±0 ,1 a**	**0,8±0,32 a**

In the same column, the means assigned the same letters are not significantly different (Newman keuls 5%)

4. DISCUSSION

The study of the effect of early upward tapping on the agrophysiological parameters of clone PB 260, during four years of upward tapping, shows that the average tree and tapping productivity (107.00 $g.t^{-1}.t^{-1}$) and kilogram per hectare (4450 $kg.ha^{-1}.yr^{-1}$) of the different treatments are good. This productivity at the tree and at the tapping is largely superior to the average productivity (between 65 and 80 $g.t^{-1}.t^{-1}$) in downward and upward tapping obtained from the works of [10-14]. Moreover, the yield obtained is higher than the national average annual yield of 1700 $kg.ha^{-1}.yr^{-1}$, which is among the best in the world. These results show that early upward tapping positively affects tree production, and despite the reduction in notch length from half spiral in downward tapping to quarter spiral in upward tapping, upward tapping is significantly more productive. This result is contrary to the findings of [10] analysing the effect of reducing the length of the tapping notch on the productivity of the rubber tree. According to this work, short notches are less metabolically active than long notches. However, this result further confirms the fact that a properly exploited short notch, good tapping frequency and good concentration of stimulating pulp Etherephon, is at least as productive as a long notch [14]. Furthermore, they confirm the findings of the work of many authors who have shown that upward tapping produces 25% more than downward tapping [5, 15].

Despite the good production level of the PB 260 clone, the average annual increase in trunk circumference of the trees is also of a good level. This result reflects the fact that the photosynthates necessary for latex production (secondary metabolism) within the laticifers [16], and for primary biomass production are consequently available to feed these two metabolisms equally within the tree. It also indicates a low impact of rubber production on tree trunk thickness growth [17]. In this respect, the highest intra-lactose availability could be the one for which the antagonism between growth and production is the lowest [18]. This confirms once again an increased and especially non-limiting intracellular sucrose availability at the PB 260 clone level, regardless of the early upward tapping delay [20,21] Furthermore, early upward tapping trees (6 years, 7 years, 8 years) expressed relatively less sensitivity to tapping panel dryness than the downward tapping control. This result shows that early upward tapping is a practice that elicits less physiological disorder leading to the onset and exacerbation of dry notch. This statement is similar to and corroborates numerous studies [21, 14, 20, 15] conducted under upward tapping.

The occurrence and evolution of tapping panel dryness is not a limiting factor in improving the productivity of a rubber plantation under upward tapping, especially early tapping [21, 3]. The higher rate obtained by down-tapping trees indicates that the applied half-spiral causes an overexploited state in the trees well before upward tapping. These assertions are supported by the findings of studies by Krishnakumar and Jacob [22] on the effect of changing the panel of a tree with tapping panel dryness in rubber trees. This work indicated that once a tree is affected by this disorder, it will likely develop on other panels as well. From this statement, we can deduce that trees bled at 6, 7, 8 years in reverse tapped are less likely to be affected by this disorder.

In terms of physiological parameters, the very high latex dry extract rate reflects a high activity of the latex and therefore rubber regeneration metabolism, and the rubber factory, which is the laticifier cell, has been running or functioning with a good yield [23]. This high activity is the same regardless of the time of upward tapping. This justifies a good regeneration of the latex exported in upward tapping, because the dry extracts, the dry matter of the latex, reflect the efficiency of isoprenic syntheses within the laticifere cells as highlighted by Jacob et al. [24].

The sucrose content was very low at the beginning and average at the end of the experiment. In view of the high Pi content of the latex, this low sucrose content, which is characteristic of metabolically active clones, is probably due to a high utilization of sucrose in the rubber production mechanism. These results corroborate those obtained from the work of many authors [20, 18]. The increase in content at the end of the trial shows that the trees still have a good supply of photosynthates [24].

Inorganic phosphorus in the latex can be considered as an indicator of the energy intensity of the metabolism of the laticifier cells [25]. Its average and high level expressed by the different treatments is due to the fact that the PB 260 clone of the fast metabolic activity class, like all other clones of this metabolic class, is known to have high inorganic phosphorus contents in the latex [16, 18]. This is one of the characteristics of clones of this metabolic activity class, and is also a good indication that the availability of metabolic energy in the laticifers is not a limiting factor in production. This explains the good rubber productivity of this clone in this study regardless of the latex harvesting technology.

Thiol groups are a major parameter of latex diagnosis [26], as they determine the physiological state of the laticifers of the bled trees. In our trial, they were low at the beginning, and at a good level after four years of experimentation. This low level at the beginning is not the result of a weak protection, but rather of the low sugar content, another limiting factor. Indeed, the regeneration of the thiol group also requires energy in the form of ATP and therefore also depends on a part of the sugar available in situ, since it is the origin of the molecular carbon [25, 18].

5. Conclusion

At the end of this study, which aimed to evaluate the effect of early upward tapping on the agrophysiological and sanitary parameters of clone PB 260, we can conclude that early upward tapping does not negatively affect the productivity of the trees of this clone, quite the contrary. Productivity was very good overall, but that of the trees tapped in reverse at less than 10 years of age was higher than that of the downward bled trees, with a rate of 42%. In addition, the radial vegetative growth was satisfactory, the tapping panel dryness rate negligible and the physiological profile balanced. From these results, we can conclude that upward tapping can be started as early as the sixth year without risk of negatively affecting the physiological condition of trees of clone PB 260.

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