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Effect of Ethephon Stimulation on Downward Tapping in Latex Production Metabolism on Upward Tapping in PB 217 Clone of Hevea Brasiliensis

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Abstract—*In Hevea brasiliensis, Ethephon is used as an exogenous stimulant of latex production. In downward tapping, it has been shown that its misuse has negative consequences on the metabolism of the latex cells of the tree. However, little is known about the impact of this downward tapping practice on latex-producing metabolism in upward tapping. The aim of this study was to determine the effect of stimulation in downward tapping on the latex-producing metabolism in clones PB 217, when the trees are subsequently tapped up. Study was carried out by monitoring the evolution of biochemical parameters of latex and rubber production. From this study, it was found during the last two years of downward tapping that in PB 217 clone, the optimal metabolism of latex production was obtained with 13 Ethephon stimulations per year. When subsequent tapping is done upward, the stimulation frequencies of the trees greater than 4 times per year in downward tapping have a negative impact on the latex-producing metabolism in PB 217 clone of Hevea brasiliensis. However, in cumulative production over the 10 years of downward tapping added to the 2 years of upward tapping, it is the frequency of 13 stimulations per year in downward tapping which is the highest.*

Keyword— Ethephon stimulation frequency, downward tapping, upward tapping, production potential, PB 217 clone of Hevea brasiliensis.

I. INTRODUCTION

In Hevea brasiliensis at maturity, latex production is usually done in three phases. The first phase consists of tapping the tree on the pristine bark of the trunk at a height of 1.20 m from the ground, according to the direction from top to bottom. This phase is called downward tapping. In the second phase, the tapping begins above the first opening and is conducted in the direction from the bottom to the top of the trunk. It is called upward tapping. Finally, the third phase is conducted like the first but on the newly formed bark resulting from the first phase. For this reason, it is called tapped on regenerated bark[1]. In each of these three phases, the Ethephon, an ethylene-generating compound, is used as an exogenous stimulant for latex production. This method, widely adopted by rubber planters, prolongs the flow of latex and stimulates the metabolism of latex cells[2,3,4,5]. However, it has been shown that, in downward tapping, its abusive use has negative consequences on the tree latex cells metabolism[6,7]. In the short or medium term, depending on the intensity of the stimulation or the clone, the production capacity of the trees, also called production potential, is strongly affected, in downward tapping. This is reflected in

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the external sign, which is the increase tapping panel dryness (TPD) rate[8,9].

However, the impact of this stimulant product used in downward tapping on the production potential of the tree, in upward tapping, has been little studied.

Some work[10,11] has shown that in the PB 260 clone which has a low tolerance to stimulation and the GT1 clone which has an average tolerance, stimulations beyond of 4 and 6 times per year respectively, in downward tapping, reduces the production potential of the trees, in upward tapping. For the clone PB 217 which has a better tolerance to Ethephon stimulation in downward tapping[12,13], the impact of the stimulation in downward tapping on the production potential, in upward tapping, is not well known. The aim of this study is to determine in PB 217 clone, the effect of downward tapping stimulation on latex-producing metabolism when trees are harvested following upward tapping.

The study was carried out by monitoring the evolution of the latex biochemical parameters such as dry rubber content (DRC), sugar (Suc), thiol (R-sh) and inorganic phosphorus (Pi) concentration, tapping panel dryness (TPD) rate and tree production. This follow-up was linked with different stimulation frequency in downward tapping.

II. MATERIAL AND METHODS

Plant Material

The Plant material used in this study was the clone PB 217 from Hevea brasiliensis planted at the CNRA Anguédédou experimental station in southeastern Côte d'Ivoire. This clone is characterized by a high tolerance to Ethephon stimulation in downward tapping. The first tapping of the trees was done at 6 years and 10 months.

Methods

Experimental device

The experiment was carried out using a totally randomized single tree plot design with 9 treatments in downward tapping which are stimulation frequencies and 33 trees per treatment for a total of 297 trees during the experimentation. The empty slots of the edge of the trees and the neighboring trees on the line were eliminated from the test to minimize edge effects.

The stimulation of production was made with a mixture (stimulating paste) of Ethrel and palm oil (adjuvant). Ethrel is a commercial product with 2-chloroethylphosphonic acid or Ethephon (ET) as active material (m.a.).

The production system used in downward tapping is the notched half-spiral every 4 days except sunday, stimulated with 1 g of paste with 2.5% of active material, applied to the regenerating panel above the notch (S/2 d4 6d/7 ET 2.5% Pa 1 (1)).

In upward tapping, a single stimulation frequency was applied for all treatments. That is 13 frequency stimulations per year (13/y). The production system used is the quarter spiral tapped every 4 days except sunday, stimulated with 1 g of paste with 5% active material applied to the regenerating panel below the groove notch (S/4 U d4 6d/7 ET 5% Pa 1 (1)).

The various treatments which are stimulation frequencies in downward tapping and in upward tapping are presented in Table 1.

Collected Data

The collected data are 4 biochemical parameters of the latex which are Dry Rubber Contents (DRC), Sucrose (SUC), inorganic Phosphorus (Pi) and Thiol groups (R-SH)) and Production in grams per tree per tapping (g/t/t), in grams per tree per millimeter of notch (g/t/mmN) and gram per tree cumulated (g/t.cum), 9, 10, 11 and 12 years old.

Measurement of latex biochemical parameters

The biochemical parameters were measured on fresh latex harvested in the field at the level of the trees of the various treatments and brought back to the laboratory.

The measured parameters are DRC, SUC content, Pi content and R-SH content of the latex[14].

Tapping panel dryness percentage determination

The tapping panel dryness (TPD) percentage at each treatment was estimated from a dry notch length measure (DNLM).

The DNLM is a visual assessment of the exudation of the latex at the indented area, called notch. During the DNLM, trees are considered " healthy " these are trees which exude the latex over the entire length of the notch after the tapping. They are scored zero (0). Others who do not exude any latex or a portion of the notch after tapping are considered diseased trees and are rated from 1 to 6 along the length of non-production of latex notch (Table 2).

The percentage of TPD is obtained by the following formula:

$$TPD=\frac{0.1*n1+0.3*n2+0.5*n3+0.7*n4+0.9*n5+1*n6}{N}*100$$

Where N represents the number of trees per treatment. Coefficients 0.1; 0.3; 0.5; 0.7; 0.9 and 1 are the mean percentages of classes of non-production notch length latex. Numbers n1; n2; n3; n4; n5 and n6 represent the number of trees observed by length class percentage of non-producing latex notch.

As part of this study, a DNLM was made in November each year on all living trees of the experimentation and TPD

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percentage of each treatment was calculated year by year.

Production estimation

The production of each treatment was estimated tree-by-tree by weighing the coagulated latex in the polybag sachets after tapping. A conversion coefficient of the dry rubber with fresh rubber was determined for each treatment by the following formula:

$$C=\frac{DW}{FW}$$

Where FW is the fresh weight of a coagulum sample, and DW is the weight of the same sample after spinning and drying.

This coefficient, which is calculated for each treatment, is multiplied by the total weight of fresh rubber of the 6 tapping to obtain the monthly dry rubber production of the treatment. For the production in grams per tree per millimeter of notch (g/t/mmN), notch lengths (*NL*) were calculated from the average circumferences (Cir) of the trees of each treatment measured at 1m 70 from the ground, after each tapping campaign, using the following formulas:

- in downward tapping:

$$NL = \frac{Cir}{2\cos 33}$$

- in upward tapping:

$$NL = \frac{Cir}{4\cos 45}$$

The values obtained were compared with the average annual production of treatments to determine the yield per tree per millimeter of notch.

Statistical methods

Analyzes of the variances for all the studied parameters were carried out using the Student-Newman-Keuls statistical test at the risk α = 5%. The statistical software used is Statistical Package for Social Sciences (SPSS).

TPDs, which are proportions, have been transformed into the Arc Sinus TPD Square Root (ASINTPD) to render the distribution normal and to stabilize the variances in order to make statistical analysis possible[15].

III. RESULTS

The data analyzed cover 4 years of observation at the level of the biochemical parameters and the rate of length of dry notch. These are the last two years of downward tapping (years 9 and 10) and the first two years of upward tapping (years 11 and 12). In addition to the data for these four years, the cumulated values of production up to the 12th year have also been analyzed.

Evolution of latex biochemical parameters in downward tapping as a function of Ethephon stimulation frequency

Biochemical parameters of latex in the penultimate year of downward tapping (year 9)

Depending on the Ethephon stimulation frequency, the biochemical parameters of latex in the penultimate year of tapping (year 9 of tapping) are as shown in Table 3. The dry rubber contents (DRC) and inorganic phosphorus of the latex did not vary, irrespective to the stimulation frequency in the 9th year of downward tapping. Conversely, the levels of sucrose and thiol groups show variation as a function of the Ethephon stimulation frequency. Latex sucrose content decrease significantly from the unstimulated treatment to reach these lower values in the treatments stimulated 38 and 78 times per year. As for latex thiol content, it remains statistically identical from the non-stimulated treatment to the stimulated treatment 8 times a year, then decreases significantly to reach its lowest value in treatment stimulated 78 times a year.

The levels of the biochemical parameters allow the 8 treatments to be grouped into 6 classes according to the resemblance of the biochemical profiles numbered D1 to D6. Class D1 groups the non-stimulated treatment. At this level, all biochemical parameters are at their maximum values. Class D2 groups stimulated treatments 2, 4 and 8 times per year. This class differs from the former by the significant decrease in the latex sugar content. At the level of class D3 which is constituted by the treatment stimulated 13 times a year, in addition to the significant reduction of latex sugar content, there is a significant decrease in the thiol content compared with D1 and D2 classes. Class D4 is constituted by treatment stimulated 26 times a year. At the level of this class, the sugar content is significantly lower compared to that of class D3. Class D5 is constituted by treatment stimulated 39 times a year. It has the lowest sugar content with thiol levels significantly lower than that of class D4. Treatment stimulated 78 times per year is class D6. This class, in addition to having low sugar content, has the lowest thiol value.

Biochemical parameters of latex in the last year of downward tapping (year 10)

In the last year of tapping, evolution of latex biochemical parameters is as indicated in Table 4. The dry rubber contents remain statistically equivalent from the non-stimulated treatment to the stimulated treatment 78 times per year. At the level of latex inorganic phosphorus (Pi) content, there was a significant increase in the non-stimulated treatment at the stimulated treatment 4 times a year when it reached its

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maximum value. From 4 to 39 stimulations per year, latex Pi content is statistically equivalent and then decreases significantly in the treatment stimulated 78 times per year. Regarding sugar levels, they remain statistically and significantly higher equivalent to non-stimulated treatment with stimulated treatment 4 times a year. The sugar content then decreases with increasing stimulation frequency to reach its lowest value significantly at the stimulated treatments 39 and 78 times per year. The sugar content at these last two frequencies is statistically equivalent. As for thiols, their concentrations do not statistically vary from non-stimulated treatment to treatment stimulated 4 times a year and show values that are significantly higher. Above 4 stimulations per year, the thiols in the latex decreased significantly to reach their lowest levels of treatment stimulated 78 times per year. The evolution of the thiol content in the latex as a function of the stimulation frequency in the last year of tapping is similar to that of sugars.

The combined analysis of the four parameters allowed the constitution of six classes according to the similarity of the biochemical profiles. Thus, class D'1, represented by the treatment that has not been stimulated has the lowest Pi content with the three other parameters at their statistically highest levels. The class D'2 is constituted by the stimulated treatments 2 and 4 times a year. At the level of this class, the four biochemical parameters have the highest values. The class D'3 regroups the stimulated treatments 8 and 13 times per year. The sugars and thiols are significantly lower compared to the D'1 and D'2 classes. In the case of class D'4 which is represented by the stimulated treatment 26 times a year, it is characterized by a concentration sugar and thiols significantly lower than those of class D'3. Concerning the class D'5 which was stimulated 39 times a year, the sugars and thiols in the latex still fell significantly with reference to D'4. The last class D'6 is constituted by the treatment stimulated 78 times a year. This treatment at a concentration of Pi in its latex is statistically similar to that of the non-stimulated treatment and is significantly lower. Added to this, are the concentrations of sugars and thiols of the latex which are also the lowest.

Evolution of the tapping panel dryness (TPD) rate as a function of the rate of stimulation in downward tapping

During the last two years of downward tapping (year 9 and 10), TPD rate in clone PB 217 (Table 5) does not change linearly. However, the lowest rates are generally observed in the treatment that is not stimulated or stimulated only slightly (2 to 4 stimulations per year). Conversely, the highest rates are those treatments that are most stimulated (39 and 78 times per year).

Evolution of rubber production as a function of the rate of stimulation in downward tapping

Rubber production in the penultimate year of downward tapping (year 9)

Rubber production values in the penultimate year of downdraft are shown in Table 6. Analysis of production in grams per tree per tapping (g/t/t) shows that there is a significant increase of unstimulated treatment at the lowest value to treatments stimulated 8 and 13 times per year. These two treatments have productions that are statistically identical and significantly higher. Above 13 stimulations per year, g/t/t declines significantly until treatment stimulated 78 times per year.

When production is expressed in gram/tree/millimeter of tapping notch (g/t/mmTN), to account for any differences in tree size, it still shows that the growth is significantly higher in non-stimulated low value to treatment stimulated 8 times a year. However, unlike production expressed in g/t/t, it remained maximal from treatment stimulated 8 times per year to treatment stimulated 39 times per year before decreasing significantly in the treatment stimulated 78 times per year. Within this range of stimulation frequency from 8 times to 39 times per year, the production expressed in g/t/mmTN is statistically identical.

For cumulative production over 9 years of downward tapping, there was a significant increase in unstimulated treatment with stimulated treatment 13 times a year, then remained statistically identical until treatment stimulated 39 times a year and decreased significantly at the level of treatment stimulated 78 times a year. Statistically, the value was lower than that of unstimulated treatment.

Rubber production in the last year of downward tapping (year 10)

Production data as a function of the stimulation frequency in the last year of downward tapping are presented in Table 7. They show that the highest productions in g/t/t are those of the stimulated treatments 8 times and 13 times per year. The productions of these two treatments are statistically identical. Below 8 stimulations per year, g/t/t increases significantly as a function of the stimulation frequency. Above 13 stimulations per year, g/t/t decreases significantly as the stimulation frequency increases. The significantly lowest g/t/t is that of non-stimulated and stimulated 78 times per year treatments. These two treatments gave statistically identical g/t/t. Values of g/t/t in the last year of downward tapping are lower than those of the previous year.

When the production estimate is made in g/t/mmTN, it is found that the latter increased significantly from the

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treatment which was not stimulated to reach its maximum values in the stimulated treatments 13 times and 26 times a year. Above 26 stimulations per year, production in g/t/mmTN decreases significantly with increasing stimulation frequency. The production in g/t/mmTN was significantly the lowest in non-stimulated treatment. As in g/t/t, the g/t/mmTNs in the last year of downward tapping are lower than those of the penultimate year.

Yield in grams per tree cumulative (g/t.cum) over the 10 years of downward tapping increased significantly from unstimulated treatment to treatment stimulated 13 times per year. It remained statistically equivalent until treatment stimulated 39 times per year, and then decreased significantly in treatment stimulated 78 times per year. The statistically lowest cumulative yield was that of the treatment that was not stimulated.

Evolution of the biochemical parameters of the latex in upward tapping as a function of the previous one in stimulation with Ethephon in downward tapping

Latex Biochemical parameters in the first year of upward tapping (year 11 of tapping)

Table 8 shows the values of the biochemical parameters in the first year of the upward tapping as a function of the previous one in stimulation in downward tapping. At DRC level, the values are more or less statistically equivalent and significantly lower than the treatment that was not stimulated to the treatment that received 4 stimulations per year in downward tapping. It subsequently increased to its significantly highest value in treatment receiving 26 stimulations per year and then significantly decreased in treatments that were stimulated 39 and 78 times per year in downward tapping. Pi increased in the latex of the treatment that was not stimulated to reach its significantly highest value in the treatment that was stimulated 4 times per year in downward tapping. Then, inversely proportional to the frequency of stimulation received, in downward tapping, it decreases significantly to reach its lowest value in the treatment that was most stimulated in downward tapping (78 times per year). Latex sugar (SUC) content, on the other hand does not evolve according to the stimulation gradient in downward tapping. The maximum value of SUC content is that of the treatment that has not been stimulated and the minimum is that of the treatment which has been stimulated 4 times per year in downward tapping. As for the thiols (R-SH) groups, concentrations in the latex remain statistically equivalent and significantly higher from the previous treatment in stimulation in downward tapping from 0 times to 4 times per year. Beyond this precedent in stimulation in downward tapping, the R-SH content of latex in upward tapping decreases significantly to reach its lowest value in the previous treatment in stimulation in downward tapping 78 times per year.

The combined analysis of the four biochemical parameters makes it possible to group the 8 treatments into 4 classes according to the resemblance of the biochemical profiles. The U1 class includes non-stimulated treatment and stimulated treatments 2 and 4 times a year. In this class, the treatments have the lowest values of DRC and the values of Pi, SUC and R-SH are significantly the highest. Class U2 is constituted by stimulated treatments 8 and 13 times a year. At the level of this class, latex DRC are similar and significantly higher than those of the U1 class. In contrast, the contents of Pi, SUC and R-SH in the latex are significantly lower. At the level of class U3 which is constituted by stimulated treatments 26 and 39 times a year, the Pi and R-SH values are statistically identical and significantly lower compared to those of the U2 group. As for the U4 class, It is represented by treatment stimulated 78 times a year. It is characterized by its Pi and latex R-SH which are the weakest of all treatments.

Biochemical parameters of latex in the second year of upward tapping (year 12)

Latex biochemical parameters in the second year of upward tapping are given in Table 9. Among the 4 biochemical parameters, the DRC did not statistically vary in the second year of upward tapping compare to the precedent in stimulation. PI is statistically equivalent to treatment that was not stimulated compare to treatment stimulated 4 times per year in downward tapping. These values are significantly higher. Beyond the previous one in stimulation, in downward tapping, 4 times a year, the latex Pi content decreases significantly to reach its lowest value at the treatment level which received 78 stimulations per year in downward tapping. Sugars (SUC) in the second year of upward tapping significantly increased treatment that was not stimulated in downward tapping to reach its significantly highest values with treatments stimulated 2 to 13 times per year in downward tapping. Latex SUC content in the second year of upward tapping decreases to its lowest treatment value which has been stimulated 78 times per year in downward tapping. Regarding the latex thiols (R-SH) concentration, it significantly increased from untreated treatment in downward tapping to reach its significantly highest value in the previous treatment in stimulation in downward tapping 4 times a year. Beyond this precedent in stimulation in downward tapping, latex R-SH concentration decreases significantly and in a way inversely proportional to the

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frequency of stimulation received in downward tapping. The lowest value of R-SH in the second year of upward bleeding is that of the treatment which was stimulated 78 times per year in downward tapping. The level of R-SH in latex in the second year of upward tapping is generally low compar to that observed in the first year.

When the 4 biochemical parameters are considered simultaneously depending on the resemblance of the biochemical profiles, the treatments can be grouped into 7 classes. Unstimulated treatment in downward tapping constitutes class U'1. In this class, DRC and Pi are at their maximum values in contrast to SUC and R-SH which have mean values. The class U'2 is represented by the treatment stimulated twice a year in downward tapping. The concentrations of SUC and R-SH in the latex of the trees of this treatment are superior to those of treatment U'1. The treatment stimulated 4 times a year in downward tapping constitutes class U'3. All parameters are at their maximum values at that level. Treatment stimulated 8 times a year in downward tapping with Pi and R-SH contents lower than those of class U'3, constitutes class U'4. At the level of class U'5, constituted by the treatment which was stimulated 13 times per year in downward tapping, the values of Pi, SUC and R-SH are low compare to those of class U'4. The class U'6 groups the treatments stimulated 26 times and 39 times per year in downward tapping. The concentrations of Pi, SUC and R-SH are lower than those of the first five classes. The treatment which received 78 stimulations per year in downward tapping constitutes class U'7. The Pi, SUC and R-SH contents of this class are the lowest of all treatments.

Evolution of TPD rate in upward tapping as a function of the rate of stimulation in downward tapping

TPD rates in the first and second year of upward tapping are presented in Table 10.In the first year of upward tapping the rate of TPD remains statistically equivalent to the treatment stimulated twice a year with treatment stimulated 78 times per year in downward tapping. Only the treatment that was not stimulated in downward tapping has a significantly lower TPD value.

In the second year of upward tapping, the significantly higher rates of TPD were those of treatments that were stimulated 2, 4, 8 and 39 times per year in downward tapping. They have statistically identical TPD rates. The lowest TPD rates are those treated with 13 and 78 stimulations per year in downward tapping. There is no TPD rate gradient linked to the previous one in stimulation in downward tapping.

Evolution of rubber production in upward tapping as a function of the rate of stimulation in downward tapping

Rubber production in the first year of upward tapping

Production values of the different treatments during the first year of upward tapping are shown in Table 11. In g/t/t, the treatment which was not stimulated in downward tapping and the stimulated treatments 2 and 4 times per year in downward tapping have statistically similar and significantly higher productions. Beyond the previous one in stimulation in downward tapping 4 times a year, the g/t/t decreases as the frequency of stimulation applied in downward tapping is high. The statistically lowest g/t/t is that of treatment which was stimulated 78 times per year in downward tapping.

The same evolution is observed when the production is expressed in gram/tree/millimeter of tapping notch (g/t/mmTN). The highest values were those of treatments that were stimulated 0 to 4 times per year in downward tapping. The g/t/mmTN decreased further to its lowest value in the treatment that received 78 stimulations per year in downward tapping.

Cumulative production values over the 11 years of total tapping show that treatments that had a precedent in stimulation in downward tapping 8 to 39 times a year are statistically of the same order and significantly higher than those of the other treatments. The treatment that was not stimulated in downward tapping has cumulative value of production significantly the lowest in spite of the high production observed in upward tapping.

Rubber production in the second year of upward tapping

Table 12 shows the productions in the second year of upward tapping (year 12) at the level of the various treatments.

Expressed in g/t/t, production in the second year of upward tapping increases from non-stimulated treatment in downward tapping to its significantly highest value in treatment that has been stimulated twice a year in downward tapping. It then decreased significantly in inverse proportion to the previous one in stimulation to reach its lowest value in the treatment which was stimulated 78 times a year in downward tapping.

When the production is related to the length of the tapping notch (g/t/mmTN), the previous treatments in stimulation in downward tapping 0 and 2 times per year have statistically similar and significantly higher values. Beyond the previous one of 2 stimulations per year in downward tapping, the g/t/mmTN in upward tapping is the lower of the higher stimulation frequency, although, this decrease is not significant between the previous ones in stimulation of 13 to 39 times a year. The lowest value of g/t/mmTN in the second year of upward tapping was that of the treatment that was

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stimulated 78 times per year in downward tapping.

Concerning cumulative production, it is the treatment having received 13 stimulations per year in downward tapping which has the statistically highest value over the 12 years of total tapping in downward tapping.

IV. DISCUSSION

The results of the present study show that in PB 217 clone, during the last two years of downward tapping, biochemical parameter DRC does not vary from non-stimulated treatment to stimulated treatment 78 times a year. In contrast, the latex contents in Pi, SUC and R-SH undergo fluctuations according to the frequency of stimulation of the trees. DRC is thus not a good indicator of the effect of stimulation on the metabolism of tree in this clone in downward tapping. On the other hand, the fluctuations of latex Pi, SUC and R-SH contents can be assessed for the metabolic status of the laticiferous cells in relation to the stimulation frequency in clone PB 217. Analysis of the level of its three biochemical parameters coupled with that of production reveals that the eight treatments can be reorganized into six groups. These six groups represent six different metabolic statuses of laticiferous cells[16]. These metabolic statuses are more or less similar to the penultimate year and the last year of downward tapping. The group 1 formed by the unstimulated treatment with the lowest g/t/t with very high SUC and R-SH levels coupled with a low Pi concentration especially in the last year of downward tapping is in a non-activated metabolic status. The 2 and 4 times per year stimulated treatments that make up group 2 are in partially activated metabolic status. At the level of these treatments, the production in g/t/t and the Pi concentration of the latex increased significantly compared to the non-stimulated treatment, while those of the R-SH and the SUC remain always maximal. The optimum of the metabolic is located at the level of group 3 formed by the stimulated treatments 8 and 13 times a year. Indeed, at the level of this group, g/t/t reached its maximum value. The three biochemical parameters significantly decreased without reaching the critical thresholds[7] and TPD rate is not in the ascending phase. From 26 stimulations per year, g/t/t decreases inversely proportional to the stimulation frequency. The R-SH falls below the minimum threshold of 0.5 mM[17] and TPD rate increases linearly. This evolution of production and biochemical parameters shows a gradual decline in the metabolic status from group 4 (treatment stimulated 26 times a year) to reach its final stage in group 6 (treatment stimulated 78 times a year). PB 217 clone therefore needs to be stimulated 13 times per year in the 9th and 10th year of downward tapping to reach its optimum metabolic. Similar results have been reported by Gohet[18]. PB 217 clone has a high tolerance to Ethephon stimulation[19]. Evolution of the metabolic status of the latex cells as a function of the stimulation frequency of PB 217 clone is different from those of PB 260 and GT 1 clones[10,11]. In these two clones, during the last two years of downward tapping, the metabolism of the latex cells is already at its optimum at zero stimulation per year. Stimulant intake during the last two years has a depressive effect on the metabolism of latex cells in these two clones. In PB 271 clone, when the production is expressed in g/t/mmTN, it is observed that it remains statistical maximum up to the stimulated treatment 39 times a year. This confirms the observations of Lacote[12] which show that PB 217 clone can withstand 39 stimulations per year up to 7 years of downward tapping. However, the present study shows that from 13 to 39 stimulations per year, the ceiling of the production expressed in g/t/mmTN shows a depressive effect of the stimulation on the trees growth, as mentioned by Gohet[20]. Analysis of TPD levels indicates that beyond 13 stimulations per year, this rate increases linearly, showing that stimulation becomes harmful to latex production of the trees. It thus appears that the physiological optimum of production of PB 217 clone is reached at 13 stimulations per year in downward tapping.

As a result of downward tapping with different stimulation frequencies, when the trees are tapped upwards with a frequency of stimulation standardized to 13 times per year, in the first year, analysis of biochemical parameters and production makes it possible to group the treatments into four metabolic statuses of the latex cells. Group 1 consists of the previous treatments in stimulation, in descending bleeding, from 0 to 4 times per year. The biochemical parameters in this group are at an optimal level, with respect to the thresholds[21]. The productions in g/t/t and g/t/mmTN of these three treatments are statistically identical and significantly the highest. The metabolic status of the laticiferous cells of the trees of these treatments can be described as good. Group 2 consisting of stimulated treatments in downward tapping 8 and 13 times a year, shows latex cells in a poorer metabolic state with productions in g/t/t and g/t/mmTN, which are significantly down from those in Group 1. However, this metabolic status can be described as fairly good because the level of biochemical parameters is still above the thresholds[21]. Group 3 is formed by treatments that have been stimulated in downward tapping 26 and 39 times a year. Given the level of biochemical parameters close to the threshold values and the production values in g/t/t and g/t/mmTN which are significantly lower compared to group 2, the metabolic status of the latex cells of this group 3 can be characterized as passable. The last group consisting of the previous treatment in stimulation in downward tapping of 78 times per year, has

latex Pi and R-SH contents below the threshold[21]. The productions in g/t/t and g/t/mmTN are the lowest. The metabolic status of the latex cells can therefore be described as mediocre. It can be seen that when going from group 1 to group 4, the metabolic status of the latex cells decreases from good to poor. Thus, in the first year of upward tapping, the production potential of PB 217 clone decreased beyond the previous one in stimulation in downward tapping 4 times a year. In the second year of upward tapping, 7 classes of metabolic statuses were established, in connection with the stimulation frequency in downward tapping. Analysis of biochemical parameters and production at these classes shows a decreasing gradient of the latex-producing metabolism from treatment receiving 4 stimulations per year to the treatment which was stimulated 78 times per year in downward tapping. As a result, the tree potential of production in the second year of upward tapping decreases from the treatment that has been stimulated 4 times a year to reach its lowest level in treatment receiving 78 stimulations per year in downward tapping.

These results show that in the BP 217 clone, the stimulation frequencies greater than 4 times per year in downward tapping have a negative impact on the trees production potential in upward tapping. The present study also showed that in cumulative production over 12 years, 10 of which were in downward tapping and 2 years in upward tapping, the treatment stimulated 13 times a year was significantly higher. From an agronomic point of view, the frequency of 13 stimulations per year in downward tapping is therefore the one that best values the PB 2017 clone.

V. CONCLUSION

It is clear from this study that in the BP 217 clone, the frequency of stimulation of the trees in downward tapping has an impact on their production potential in upward tapping. Beyond 4 stimulations per year in downward tapping, the production potential of the trees in upward tapping decreases gradually to reach its lowest level with 78 stimulations per year.

The study also confirmed that in PB 217 clone, optimal production potential in downward tapping is reached when trees are stimulated 13 times per year. It is also this stimulation frequency of 13 times per year that gives the significantly highest cumulative production over the 10 years in downward tapping added to the 2 years in upward tapping. It therefore offers the best compromise between downward and upward tapping, economically.

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THE TABLES

Table.1: Treatments (Ethephon stimulation frequency) applied in downward tapping and upward tapping in PB 217 clone of Hevea brasiliensis.

Treatments	**Modalities**	
	Downward tapping (years 1-10) S/2 d4 6d/7 ET 2.5%	**Upward tapping (year 11-12)** S/4 U d4 6d/7 ET 5 %
A	Not tapped Trees	Not tapped Trees
B	0/Y	13/Y
C	2/Y	13/Y
D	4/Y	13/Y
E	8/Y	13/Y
F	13/Y	13/Y
G	18/Y	13/Y
H	26/Y	13/Y
J	39/Y	13/Y
K	78/Y	13/Y

S/2 d4 6d/7 ET 2.5%: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon,
S/4 U d4 6d/7 ET 5 % 13/y: quarter spiral upward tapping every 4 day except Sunday stimulated with 5% Ethephon 13 times a year,
0 to 78/Y: number of stimulation per year,

Table.2: Rating of trees with dry notch in Hevea brasiliensis

Non-latex-producing notch length (%)	Notation
01 to 20	1
21 to 40	2
41 to 60	3
61 to 80	4
81 to 99	5
100	6

Table.3: Evolution of latex biochemical parameters and metabolic status of latex cells depending on the stimulation frequency at the 9th year downward tapping in PB 217 clone Hevea brasiliensis

Treatments	Latex biochemical parameters				Classification of latex cells Metabolisms
	DRC (%)	Pi (mM)	SAC (mM)	R-SH (mM)	
S/2 d4 6d/7 ET 2.5 % **0/y**	41,3 a	10,5 a	36,2 a	0,65 a	**Group D 1**
S/2 d4 6d/7 ET 2.5 % **2/y**	40,1 a	11,9 a	27,9 b	0,69 a	**Group D 2**
S/2 d4 6d/7 ET 2.5 % **4/y**	39,4 a	12,8 a	25,6 b	0,70 a	
S/2 d4 6d/7 ET 2.5 % **8/y**	40,9 a	13,0 a	25,0 b	0,69 a	
S/2 d4 6d/7 ET 2.5 % **13/y**	42,5 a	12,3 a	22,8 b	0,59 b	**Group D 3**
S/2 d4 6d/7 ET 2.5 % **26/y**	41,9 a	12,6 a	15,3 c	0,59 b	**Group D 4**
S/2 d4 6d/7 ET 2.5 % **39/y**	42,2 a	12,3 a	11,5 d	0,51 c	**Group D 5**
S/2 d4 6d/7 ET 2.5 % **78/y**	40,2 a	11,4 a	13,1 cd	0,41 d	**Group D 6**

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
TSC: Total Solid Content, Pi: inorganic Phosphorus, SUC: Sucrose, R-SH: Thiols Groups, mM: millimolar,
a, b, c, d: homogenous group according to the test of Newman and Keuil alfa risk of 5%, y: year,
a > b > c > d,

Table.4: Evolution of latex biochemical parameters and metabolic status of latex cells depending to the stimulation frequency at the last year downward tapping (year 10) in PB 217 clone of Hevea brasiliensis

Treatments	Latex biochemical parameters				Classification of latex cells Metabolisms
	DRC (%)	Pi (mM)	SAC (mM)	R-SH (mM)	
S/2 d4 6d/7 ET 2.5 % **0/y**	43,5 a	12,3 b	22,1 a	0,67 a	**Group D'1**
S/2 d4 6d/7 ET 2.5 % **2/y**	42,3 a	13,4 ab	18,3 a	0,68 a	**Group D'2**
S/2 d4 6d/7 ET 2.5 % **4/y**	42,5 a	15,1 a	19,1 a	0,65 a	
S/2 d4 6d/7 ET 2.5 % **8/y**	42,2 a	14,6 a	14,6 b	0,62 ab	**Group D'3**
S/2 d4 6d/7 ET 2.5 % **13/y**	42,6 a	14,8 a	13,6 b	0,61ab	
S/2 d4 6d/7 ET 2.5 % **26/y**	41,6 a	15,1 a	11,0 bc	0,53 b	**Group D'4**
S/2 d4 6d/7 ET 2.5 % **39/y**	42,5 a	14,0 a	8,5 c	0,45 c	**Group D'5**
S/2 d4 6d/7 ET 2.5 % **78/y**	42,1 a	12,6 b	9,3 c	0,36 d	**Group D'6**

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78

times a year,
TSC: Total Solid Content, Pi: inorganic Phosphorus, SUC: Sucrose, R-SH Thiols Groups, mM: millimolar,
a, b, c, d: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a > b > c > d,

Table.5: Evolution of tapping panel dryness (TPD) percentage in the tow last years downward tapping (years 9 and 10) depending of stimulation frequency in PB 217 clone of Hevea brasiliensis

Treatments	After last year downward tapping (Year 9)		Last year downward tapping (Year 10)	
	TPD (%)	ASNSR(TPD)	TPD (%)	ASNSR(TPD)
S/2 d4 6d/7 ET 2.5 % **0/y**	4,0	0,201 d	4,0	0,201 e
S/2 d4 6d/7 ET 2.5 % **2/y**	3,4	0,185 d	3,4	0,185 e
S/2 d4 6d/7 ET 2.5 % **4/y**	3,3	0,183 d	8,3	0,292 d
S/2 d4 6d/7 ET 2.5 % **8/y**	9,6	0,315 bc	12,4	0,360 c
S/2 d4 6d/7 ET 2.5 % **13/y**	1,6	0,127 e	5,3	0,232 de
S/2 d4 6d/7 ET 2.5 % **26/y**	7,8	0,283 c	14,2	0,386 c
S/2 d4 6d/7 ET 2.5 % **39/y**	12,6	0,363 b	25,0	0,524 b
S/2 d4 6d/7 ET 2.5 % **78/y**	18,9	0,450 a	42,5	0,710 a

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
TPD: tapping panel dryness,
ASNSR (TPD): arc sinus square root (TPD),
a, b, c, d, e: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a > b > c > d > e,

Table.6: Evolution of latex production based on frequency stimulation on after last year downward tapping (Year 9) in PB 217 clone of Hevea brasiliensis

Treatments	Production at after last year downward tapping (Year 9)		
	g/t/t	g/t/mmTN	g/t. cum
S/2 d4 6d/7 ET 2.5 % **0/y**	78,03 c	19,44 c	31712 c
S/2 d4 6d/7 ET 2.5 % **2/y**	90,92 bc	22,58 bc	40115 b
S/2 d4 6d/7 ET 2.5 % **4/y**	100,81 b	26,12 b	42988 b
S/2 d4 6d/7 ET 2.5 % **8/y**	112,14 a	29,15 a	48188 ab
S/2 d4 6d/7 ET 2.5 % **13/y**	117,13 a	32,05 a	52558 a
S/2 d4 6d/7 ET 2.5 % **26/y**	103,84 b	30,44 a	52150 a
S/2 d4 6d/7 ET 2.5 % **39/y**	108,15 ab	30,66 a	55069 a
S/2 d4 6d/7 ET 2.5 % **78/y**	86,63 bc	25,11 b	49719 ab

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
g/t/t: gram/tree/tapping,
g/t/mmTN: gram/tree/millimeter of tapping notch
g/t.cum.: gram/tree cumulated year 1 to year 8,
a, b, c: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a > b > c,

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Table.7: Evolution of latex production based on frequency stimulation in the last year of downward tapping (year 10 of tapping) on PB 217 clone of Hevea brasiliensis

Treatments	Production at last year downward tapping (Year 10)		
	g/t/t	g/t/mmTN	g/t. cum
S/2 d4 6d/7 ET 2.5 % **0/y**	65,32 c	15,72 c	36806 c
S/2 d4 6d/7 ET 2.5 % **2/y**	75,53 b	18,75 bc	46004 bc
S/2 d4 6d/7 ET 2.5 % **4/y**	84,14 ab	21,08 b	49548 b
S/2 d4 6d/7 ET 2.5 % **8/y**	88,31 a	22,65 ab	55075 ab
S/2 d4 6d/7 ET 2.5 % **13/y**	90,62 a	24,25 a	59624 a
S/2 d4 6d/7 ET 2.5 % **26/y**	83,43 ab	23,91 a	58655 a
S/2 d4 6d/7 ET 2.5 % **39/y**	70,62 b	19,6 b	60576 a
S/2 d4 6d/7 ET 2.5 % **78/y**	66,4 c	18,9 bc	54898 ab

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
g/t/t: gram/tree/tapping,
g/t/mmTN: gram/tree/millimeter of tapping notch
g/t.cum.: gram/tree cumulated,
a, b, c: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a > b > c,

Table.8: Evolution of latex biochemical parameters and metabolic status of latex cells in 1st upward tapping year (year 11 of total tapping) depending on the downward tapping frequency stimulation in PB 217 clone of Hevea brasiliensis

Treatments		**Latex biochemical parameters**				**Classification of latex cells Metabolisms**
1st year Upward tapping	**Previous Downward tapping**	**DRC (%)**	**Pi (mM)**	**SAC (mM)**	**R-SH (mM)**	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **0/y**	45,4 bc	12,9 ab	27,0 a	0,74 a	**Group U1**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **2/y**	43,2 c	11,4 abc	24,6 abc	0,70 a	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **4/y**	43,8 c	13,3 a	25,0 ab	0,68 a	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **8/y**	46,4 abc	9,5 cde	20,1 c	0,57 b	**Group U2**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **13/y**	47,9 abc	10,7 bcd	23,4 abc	0,58 b	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **26/y**	50,4 a	10,3 cd	21,7 bc	0,51 c	**Group U3**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **39/y**	47,7 abc	9,2 cd	23,4 abc	0,51 c	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **78/y**	48,7 ab	7,5 d	21,6 bc	0,44 d	**Group U4**

S/4 U d4 6d/7 ET 5 % 13/y: quarter spiral upward tapping every 4 day except Sunday stimulated with 5% Ethephon 13 times a year,
S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
TSC: Total Solid Content, Pi: inorganic Phosphorus, SUC: Sucrose, R-SH: Thiols Groups, mM: millimolar.
a, b, c, d, e: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a>b>c>d > e,

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Table.9: Evolution of latex biochemical parameters and metabolic status of latex cells in 2nd upward tapping year (year 12 of total tapping) depending on the downward tapping frequency stimulation in PB 217 clone of Hevea brasiliensis

Treatments		Latex biochemical parameters				Classification of latex cells Metabolisms
2nd year Upward tapping	Previous Downward tapping	DRC (%)	Pi (mM)	SAC (mM)	R-SH (mM)	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **0/y**	44,4 a	15,6 a	21,4 bc	0,41 b	**Group U'1**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **2/y**	44,0 a	14,8 ab	25,7 a	0,44 ab	**Group U'2**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **4/y**	43,2 a	15,8 a	25,7 a	0,46 a	**Group U'3**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **8/y**	42,1 a	13,0 bc	25,7 a	0,41 b	**Group U'4**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **13/y**	43,9 a	12,6 bcd	23,6 ab	0,39 bc	**Group U'5**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **26/y**	45,4 a	11,2 cd	22,7 b	0,36 c	**Group U'6**
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **39/y**	45,1 a	11,2 cd	21,4 bc	0,36 c	
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **78/y**	44,9 a	10,4 d	18,7 c	0,31 d	**Group U'7**

S/4 U d4 6d/7 ET 5 % 13/y: quarter spiral upward tapping every 4 day except Sunday, stimulated with 5% Ethephon 13 times a year,

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,

TSC: Total Solid Content, Pi: inorganic Phosphorus, SUC: Sucrose, R-SH: Thiols Groups, mM: millimolar,

a, b, c, d: homogenous group according to the test of Newman and Keuil alfa risk of 5%,

a>b>c>d,

Table.10: Evolution of tapping panel dryness (TPD) percentage in the tow first years upward tapping (year 11 and 12 of total tapping) depending on the downward tapping stimulation frequency in PB 217 clone of Hevea brasiliensis

Treatments		1st year Upward tapping		2nd year Upward tapping	
Upward tapping	Previous Downward tapping	TPD (%)	ASNSR(TPD)	TPD (%)	ASNSR(TPD)
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **0/y**	1,0	0,100 b	2,0	0,142 b
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **2/y**	3,3	0,183 ab	7,0	0,268 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **4/y**	6,3	0,254 a	10,4	0,328 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **8/y**	4,0	0,201 a	8,7	0,299 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **13/y**	2,8	0,168 ab	1,0	0,100 c
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **26/y**	2,6	0,162 ab	3,7	0,194 b
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **39/y**	4,9	0,223 a	8,7	0,299 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **78/y**	5,4	0,235 a	1,1	0,105 c

S/4 U d4 6d/7 ET 5 % 13/y: quarter spiral upward tapping every 4 day except Sunday, stimulated with 5% Ethephon 13 times a year,

S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,

TPD: tapping panel dryness,

ASNSR (TPD): arc sinus square root (TPD),

a, b, c: homogenous group according to the test of Newman and Keuil alfa risk of 5%,

a > b > c,

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Table.11: Evolution of latex production in the 1st upward tapping year (year 11 of total tapping) based on downward tapping frequency stimulation in PB 217 clone of Hevea brasiliensis

Treatments		Productions		
1st year Upward tapping	Previous Downward tapping	g/t/t	g/t/mmTN	g/t. cum year 1 to 11
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **0/y**	121,20 a	30.92 a	46938,5 c
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **2/y**	116,93 a	30.88 a	56468,6 b
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **4/y**	117,21 a	31.06 a	60870,5 ab
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **8/y**	105,78 ab	28.21 b	65160,6 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **13/y**	098,65 b	28.18 b	67943,3 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **26/y**	074,18 c	22.49 c	65820,8 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **39/y**	068,08 c	20.00 cd	66958,7 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **78/y**	060,40 d	18.31 d	63523,4 ab

S/4 U d4 6d/7 ET 5 % 13/y: quarter spiral upward tapping every 4 day except Sunday, stimulated with 5% Ethephon 13 times a year,
S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
g/t/t: gram/tree/tapping,
g/t/mmTN: gram/tree/millimeter of tapping notch,
g/t.cum.: gram/tree cumulated,
a, b, c, d: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a > b > c > d,

Table.12: Evolution of latex production in the 2nd upward tapping year (year 12 of total tapping) based on downward tapping frequency stimulation in PB 217 clone of Hevea brasiliensis

Treatments		Productions		
2nd year Upward tapping	Previous Downward tapping	g/t/t	g/t/mmTN	g/t. cum year 1 to 12
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **0/y**	136.57 ab	35.16 a	57534.3 c
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **2/y**	141.99 a	36.89 a	68555.2 b
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **4/y**	131.37 b	33.90 ab	72190.3 ab
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **8/y**	120.50 c	33.43 b	75620.8 ab
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **13/y**	111.27 d	29.48 c	78043.6 a
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **26/y**	096.07 e	28.58 c	73455.7 ab
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **39/y**	096.13 e	27.88 c	75082.5 ab
S/4 U d4 6d/7 ET 5 % **13/y**	S/2 d4 6d/7 ET 2.5 % **78/y**	083.88 f	23.94 d	70528.2 b

S/4 U d4 6d/7 ET 5 % 13/y: quarter spiral upward tapping every 4 day except Sunday, stimulated with 5% Ethephon 13 times a year,
S/2 d4 6d/7 ET 2.5% 0-78/y: half spiral downward tapping every 4 days except Sunday stimulated with 2.5% Ethephon 0 to 78 times a year,
g/t/t: gram/tree/tapping,
g/t/mmTN: gram/tree/millimeter of tapping notch,
g/t.cum.: gram/tree cumulated,
a, b, c, d, e, f: homogenous group according to the test of Newman and Keuil alfa risk of 5%,
a > b > c > d > e > f,