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Effect of planting date on the agrophysiological parameters of clone GT 1 of *Hevea brasiliensis* Muell. Arg in southwestern Côte d'Ivoire

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Abstract
A study of the influence of different planting dates on the agronomic behavior of GT 1 clone rubber plants was conducted in southwestern Côte d'Ivoire. The agrophysiological and climatic data necessary for the study were collected on the experimental site of the SCASO. This test includes two sub-tests of the same methodology but with different implementation dates. One test was set up in June 1991 (under test 1) and the other in June 1992 (under test 2), according to a Fisher experimental block design, of three treatments (early, normal, and late) with four repetitions. Two latex harvesting systems were applied to all treatments; S/2 d/4 6d/7 ET 2.5% Pa 1 (1) 6/y, from the first to the second year and from the fourth year, the system, S/2 d/4 6d/7 ET 2.5% Pa 1(1) 10/y. The analyzes revealed that the rate of trees present in the plots (86.91 ± 0.27%), the vegetative growth tapping (2.36 ± 1.24 $cm.year^{-1}$) and the average annual yield (2018 ± 763 $kg.ha^{-1}.year^{-1}$) were good, and were influenced by the fluctuation of certain climatic factors. Despite good rubber productivity, the physiological profile remained good with low LEM (2.41 ± 1.85%), regardless of the date of planting. The proper timing of plantation establishment is early and normal planting.

Keywords: planting date, rubber production, GT 1, vegetative growth tapping, physiological profile

1. Introduction

The rubber tree plant (*Hevea brasiliensis*, Euphorbiaceae), which originated two centuries ago from the present Amazon basin of Brazil, has today become the object of important economic activity throughout the world, because it generates huge incomes (Rajagopal *et al*., 2003) [28]. It is the main source of natural rubber used in various fields. Indeed, natural rubber is a strategic commodity worldwide. Today, 75% of global production goes to the tire industry (Delabarre and Eschbach, 2002) [10]. Global production of natural rubber is mainly provided by Thailand, Indonesia and Malaysia, according to Anonymous 1, 2016 [1]. Côte d'Ivoire is the leading African producer of natural rubber (Obouayeba *et al*., 2018) [23], with a production of 603 000 tons in 2017. Ivorian production has increased in line with the evolution of the areas exploited (Anonymous 2, 2009) [2]. However, the stabilization of this production over time remains a major difficulty for rubber growers in the non-industrial environment. In fact, the agronomic behavior of mature rubber trees depends on the date of planting of the plant material obtained, given the importance of environmental factors on bud emission and growth. According to Nguema *et al*. (2016) [18] plantations located in the South and in the coastal zone of Cameroon illustrate this situation well. This results in a fluctuation and especially a decrease in yields (Berg, 2011) [4]. Thus, many authors (Kanohin *et al*., 2012) [14] present the climate as a limiting factor of agronomic behavior, particularly vegetative behavior.

In addition, Penot and Deheuvels (2007) [25] believe that the water deficit, the edaphic constraints, the high frequencies of the morning rains and the cold related to altitude or latitude constitute a real obstacle to the development of rubber. The best techniques for exploiting rubber trees are known throughout industrial plantations (Niéto and Rodriguez,

2007) [19] even though, according to Chambon *et al*. (2003) [7] the bulk of world rubber production is provided by village plantations (85%). According to Nguema *et al*. (2016) [18], temperature, insolation and rainfall all have a negative influence on the fate of rubber trees. Thus, considering the statements of Penot and Deheuvels (2007) [25] and Nguema *et al*. (2016) [18], it seems appropriate to compare the agronomic behavior of early and late rubber plantations with that of the June plantation, which will therefore be our reference, in order to evaluate the influence of the variation of climatic components.

The influence of climate, especially rainfall, on the behavior of the rubber tree is proven. Similarly, rubber productivity is dependent on the vigor of the plant. It therefore seems necessary to determine the best time of planting.

2. Materials and Methods

2.1 Plant material

The plant material used consists of clone GT 1 of *Hevea brasiliensis* (Mueller Argoviensis Euphorbiaceae), belonging to the vegetative growth classes (Obouayeba *et al*., 2000; Obouayeba, 2005) [21, 20] and of moderate metabolic activity (Jacob *et al*., 1988) [13]. Its choice is motivated by its hardiness, which makes it the most planted clone in the country, giving it a good and stable stand of bled trees (Chapuset *et al*., 2000) [8].

The site of the South-West Agricultural Civil Society (SCASO), has a meteorological station of Sod exam allowing to measure daily the climatic parameters which are: the temperature, the insolation and the pluviometry.

2.2 Methods

2.2.1 Study site

The works was carried out at Gô research station (Ex HEVEGO), today, South West Civil Agricultural Society (SCASO) in southwest of Côte d'Ivoire (West Africa)**.** This zone is subject to a humid equatorial climate, characterized by abundant rainfall. The average annual temperature is 26.1° C. The average annual rainfall is 1900 mm**.** The heaviest rains fall from April to July**.** A relatively dry season starts in December and extended in March (Monnier, 1983; Keli *et al*., 1992; Brou *et al*., 2005) [16, 15, 5]. The predominantly ferralitic soils are, however, derived from migmatites and shale, sandy clayed, relatively richer in exchangeable bases. They also have gravel horizons and frequent lateritic cuirasses around 1.00 m deep (Keli *et al*., 1992) [15].

2.2.2 Experimental design and treatments

Note that this experiment includes two sub-tests of the same nature (methodology) but it differs from one another by the date of implementation and the date of treatment. One trial was set up from June 1991 (under test 1) and the other in June 1992 (under test 2) at the same experimental site of the GO Hexicultural Society (Ex Hevego) in Southwest Côte d'Ivoire. The trial consisted of three treatments arranged in Fisher block with four replicates, on a surface of 4.91 ha, planted at the density of 510 t / ha (7 meters between lines and 2.8 meters between plants) on an underground ground. The purpose of the study is to compare the influence of different planting dates on radial vegetative growth and the rubber production of grafted seedlings and planted in 10-month sacks in order to better orient planters in the non-industrial environment.

The different treatments compared were as follows

- **Under test 1**

1: Early planting moment (May)
2: Moment of normal planting (witness; June)
3: Late planting moment (September)

- **Under test 2**

T1: Early planting moment (April)
T2: Moment of normal planting (witness; June)
T3: Moment of late planting (October)

- **Latex harvesting technology**
- **Treatments or tapping systems**

All treatments were tapped at the same time, that is, at 6 years 3 months after planting. Two latex harvesting systems were applied to all treatments; S / 2 d / 4 6d / 7 ET 2.5% Pa 1 (1) 6 / y, from the first to the second year and from the fourth year, the S / 2 system, d / 4 6d / 7 ET 2.5% Pa 1 (1) 10 / y. The tapping takes place the first two years on panel A (BO-1) and the third year on panel B (BO-2), with subsequent alternating tapping, from the 4th year, of the two panels up to at the ninth year of planting (Gohet *et al*., 1991) [11].

2.2.3. Measurements and data processing

2.2.3.1 Climate data

Climate data was recorded on digital media at Sod exam (Côte d'Ivoire). The different climate variables are defined as follows:

For the temperature (T); rainfall (P), and insolation (INS), the data were respectively on the intensity of heat, the amount of water in mm (Pmm) and its monthly distribution (Pm) firstly, on the one hand, and the duration of insolation in hours (INSh) and its monthly distribution (INSm) on the other hand. The collected climate data have been concerned the period of 16 years to the South West Civil Agricultural Society (SCASO).

2.2.3.2 Rubber production

Each tree latex yield was measured by weighing the cumulative coagulated rubber every four weeks. Total solid content was measured from a bulk sample taken in each treatment in order to convert fresh weights into grams of dry rubber per tree. Latex yield was expressed in kilograms per hectare ($kg.ha^{-1}$), grams per tree ($g.t^{-1}$) and grams per tapping per tree ($g.t^{-1} t^{-1}$).

2.2.3.3 Radial vegetative growth

The annual growth in centimeter (cm) and girth increment in centimeter per year ($cm.year^{-1}$) of the trees was assessed every year at 1.70 m from the ground, during the nine years of the experiment.

2.2.3.4 Visual estimation of the tapping panel dryness

On certain trees, during tapping, the flow of latex is abnormally weak or even nonexistent; a more or less important part of the cut does not produce latex. It’s a symptom of tapping panel dryness (TPD). In addition, TPD was assessed by visual estimation of dry-cut length on each tree which enables to report on the evolution of the symptom. On that respect, the trees tapped were rated from 0 to 6 in proportion to the progress of the disease according to the code below. 0: healthy cut, normal flow all along the tapping cut 6: completely dry cut.

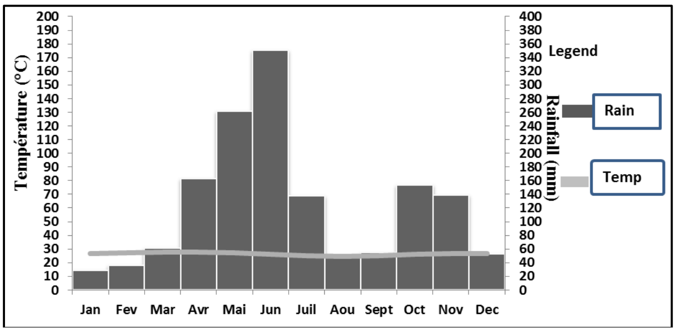
NAV= N- NAS
For each treatment, the percentage of live trees (Live Trees %) was determined by the following relationships:

%NAV=NAV x 100 x N^{-1}
NAV: number of live trees; N total number of trees; NAS: number of dry trees.

2.2.3.5 Latex analysis
The latex diagnosis per treatment was carried out every year between September and November. The biochemical parameters such as dry rubber content (DRC), sucrose (Suc), inorganic phosphorus (Pi) and thiols contents (RSH) were evaluated. Sucrose (Suc), inorganic phosphorus (Pi) and thiols (RSH) contents were measured on the clear serum called TCA-serum (trichloroacetic acid) that obtained after latex acid coagulation, respectively, by the anthrone method, Ashwell (1957) [3] the molybdate ammonium method Taussky and Shorr (1953) [29] and the acid dinitro-dithio-dibenzoic method Boyne and Ellman (1972) [6]. The results are stated in millimole per litre of latex (mmol.l^{-1}). DRC represented the percentage of dry rubber in latex, a latex sample was weighed before and after drying in oven at 80 °C for 24 h. Sucrose reflected the balance between sucrose consumption by the laticifer (for energy production and rubber biosynthesis) and sucrose loading from the apoplast into the laticifer. Pi indicated the level of availabled energy in the metabolic activity of the laticifer. RSH indicated the level of lutoids protection and the stability of latex. Sucrose, Pi and RSH contents were expressed in millimoles per litre of latex (mmol.l^{-1}).

3. Statistically analysis
Shed focused on rubber production data, isodiametric trunk growth, latex micro diagnostics, sick slot length and fluctuating climatic variables from one year to one other year during the experiment. The agrophysiological and health data were processed using Statistica 7.5 statistical software. An analysis of variance was performed and the significance level of the differences between the means was estimated by the Newman-Keuls test at the 5% threshold.

4. Results
4.1 Effects of planting date on GT1 clone after nine years of experimentation
4.1.1 Climate data
4.1.1.1 Monthly rainfall
Figures 1 and 2 has illustrated the year-to-year fluctuations in climatic parameters observed at the SCASO site in southwestern Côte d'Ivoire from 1990 to 2006. The monthly rainfall averages has allowed identified three types of months in this part of the country:
The months with low rainfall (average monthly height less than 100 mm). These are the months of December, January, February and March. These months marked the long dry season in southwestern Côte d'Ivoire. The maximum monthly height for each month does not reach 60 mm (Figure 1). The months of August and September were also low rainfall months in southwestern Côte d'Ivoire.
The Months with intermediate rainfall (average monthly height between 100 and 200 mm). The month of April has been an intermediate month that generally announced the arrival of the great rainy season. During these months, the number of rainy days increased compared to previous months (Figure 1). The months of October and November were also among the months of moderate rainfall. This period of the year corresponds to the installation of the second rainy season (or small rainy season) in the south-west of Côte d'Ivoire (Figure 1).
The Months of high rainfall (average monthly height between 200 and 600 mm). May and June were the more-rainy of the year in the southwestern Ivorian region. The highest rainfall amounts were recorded in June when rains in this region exceeded 350 mm (Figure 1). The very rainy character of these two months and the length of the period, compared to the rainy season of October and November, qualify this first rainy season of "great rainy season".



Source: SODEXAM San Pedro Airport.

Fig 1: Ombrothermal diagram of the study area over the period 1990-2006

4.1.1.2 The Temperatures and duration of insolation
The duration of insolation was most important during the first four months of the year. We recorded, more than 203 hours of sunstroke for each month. As much as the temperatures, it was in July, August, September and October that that we observed insolation times the more low (133, 110, 134 and 140 hours) were observed during the year (Figure 2).

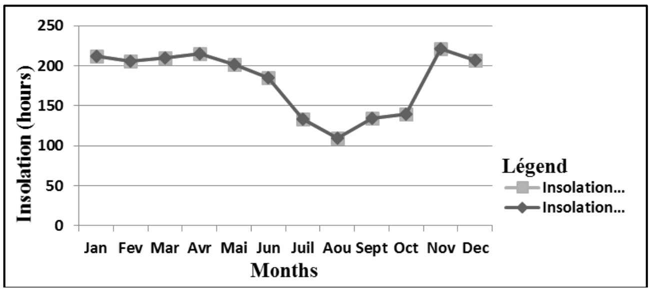


Fig 2: Evolution of insolation (hours) in the study area over the period from 1990 to 2006 (Source: SODEXAM San Pedro Airport).

4.1.2 Live tree rate
The population density of living trees in Sub-Study 1 was the same for all treatments (Table 1), at the first year of tapping of rubber and the end of the experiment respectively (90.9 ± 0.29 and 87.9 ± 0.33%). Planting date had no effect on tree losses (breakage or uprooting).
Regarding, the rate of trees present in the plots, on the other hand, varied both in the first year of tapping of rubber and at the end of the experiment (86.23 ± 0.26%, 82.63 ± 0.21%) according to planting date (Table 2). Late-planting plots had a statistically lower proportion (81.6 ± 0.24%) of living trees compared to the other two treatments (early and normal).

Table 1: Live tree of GT 1 clone subject to different planting dates (under test 1) after nine years experimentation

Treatments	Live trees (%)	
	Start (At tapping)	End (After 15 years of experimentation)
Early (22/05/91)	90,4 ± 0,35 a	88,6 ± 0,29 a
Normal (Co;29/06/91)	91,3 ± 0,21 a	88,8 ± 0,27 a
Late (02/09/91)	91,0 ± 0,31 a	86,3 ± 0,45 a
Average	90,9 ± 0,29	87,9 ± 0,33

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). **Liv Trees**: Live trees expresses in percentage; **Co**: control

Table 2: Live tree of GT 1 clone subject to different planting dates (under test 2) after nine years experimentation

Treatments	Live trees (%)	
	Start (At tapping)	End (After 15 years of experimentation)
Early (22/04/92)	87,1 ± 0,23 a	84,3 ± 0,25 a
Normal (Co 17/06/92)	88,9 ± 0,26 a	83,2 ± 0,19 a
Late (15/10/92)	82,7 ± 0,28 b	80,4 ± 0,18 b
Average	86,23 ± 0,26	82,63 ± 0,21

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). Liv Tre: Live trees expresses in percentage; **Co**: control.

4.1.3 Rubber yield

4.1.3.1 To the tree and per tapping ($g.t^{-1}.t^{-1}$)

Mean tree production and rubber tapping (54.58 ± 5.4 g) of clone GT 1 was significantly influenced by planting date after nine years of experimentation (Table 3). Indeed, the late treatment with 53.78 ± 5.9 g, significantly produced less rubber than the early pattern (56.04 ± 4.2 g). However, its $g.t^{-1}.t^{-1}$ was statistically identical to that of normal treatment (control, 53.92 ± 6.1 $g.t^{-1}.t^{-1}$).

Regarding sub-test 2, the average production of the tree and at tapping ($g.t^{-1}.t^{-1}$), all parcels combined was of a good level 58.63 ± 4.23 g. the tapping of trees planted in the normal period yielded the highest rubber yield (59.4 ± 4.9 g) and was statistically identical to early and late planted trees (Table 4).

Table 3: Average rubber production and average annual circumference growth of GT 1 clone at different planting dates (under test 1) after 9 years of experimentation

Treatments	Yield ($g.t^{-1}.t^{1}$)	Yield ($g.t^{-1}.y^{-1}$)	Yield ($kg.ha^{-1}.y^{-1}$)	Incr ($cm.y^{-1}$)
Early (22/04/92)	57.5 ± 4,1 a	4568 ± 934 a	2025 ± 806 a	2,43 ± 1,28 a
Normal (co 17/06/92)	59.4 ± 4,9 a	4534 ± 927 a	2026 ± 723 a	2,37 ± 1,24 a
Late (15/10/92)	58.99 ± 3,7 a	4296 ± 878 b	1879 ± 703 b	2,03 ± 1,06 b
Average	58,63 ± 4,23	4466 ± 913	1977 ± 744	2,27 ± 1,19

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). ($g.t^{-1}.t^{-1}$): To the tree and per tapping; ($g.t^{-1}.y^{-1}$): at the tree and per year; ($kg.ha^{-1}.y^{-1}$): Productivity per hectare; Yield: Rubber yield; Incr: Average annual increment (cm/year)

Table 4: Average rubber production and average annual circumference growth of GT 1 clone at different planting dates (under test 2) after 9 years of experimentation

Treatments	Yield ($g.t^{-1}.t^{-1}$)	Yield ($g.t^{-1}.y^{-1}$)	Yield ($kg.ha^{-1}.y^{-1}$)	Incr ($cm.y^{-1}$)
Early (22/04/92)	57.5 ± 4,1 a	4568 ± 934 a	2025 ± 806 a	2,43 ± 1,28 a
Normal (co 17/06/92)	59.4 ± 4,9 a	4534 ± 927 a	2026 ± 723 a	2,37 ± 1,24 a
Late (15/10/92)	58.99 ± 3,7 a	4296 ± 878 b	1879 ± 703 b	2,03 ± 1,06 b
Average	58,63 ± 4,23	4466 ± 913	1977 ± 744	2,27 ± 1,19

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). ($g.t^{-1}.t^{-1}$): To the tree and per tapping; ($g.t^{-1}.y^{-1}$): at the tree and per year; ($kg.ha^{-1}.y^{-1}$): Productivity per hectare; Yield: Rubber yield; Incr: Average annual increment (cm/year)

4.1.3.2 At the tree and per year ($g.t^{-1}.y^{-1}$)

At the end of the experiment, the average annual production of the tree and by year of under test 1 (4543 ± 928 g) has been satisfactory. It varied from one date to another (Table 3). Indeed, the productions fluctuated from 4383 to 4645 $g.t^{-1}.year^{-1}$, the highest production has been that of the early planting treatment (4645 $g.t^{-1}.year^{-1}$), statistically identical to the normal planting treatment (control; 4600 $g.t^{-1}.y^{-1}$) and superior to late planting treatment (4383 $g.t^{-1}.year^{-1}$).

In nine years of experience of sub-test 2, the clone GT 1 produced an annual average (4466 ± 913 $g.t^{-1}.y^{-1}$) of rubber (Table 4). Plots of late and normal planting showed respective productions (4296 ± 878, 4534 ± 927 $g.t^{-1}.year^{-1}$) significantly different from each other. However, the yield of the control (normal planting) was significantly identical to that of early planting (4568 ± 934 $g.t^{-1}.year^{-1}$).

4.1.3.3 Productivity per hectare

Table 3 (sub-test 1) shows the average annual production in kg per hectare (2059 ± 781 $kg.ha^{-1}$) of rubber, which was at a very good level. The average annual production per hectare was significantly influenced by the timing of planting. Indeed, the productivity of trees planted late was statistically lower (1970 ± 747 $kg.ha^{-1}$) than that of other treatments, who have statistically identical productions.

The productivity per hectare in the case of the under-test 2, all treatments combined (Table 4), was particularly good with 1977 ± 744 $kg.ha^{-1}.year^{-1}$. The timing of planting significantly influenced tree yield. The rubber trees planted normally (control: 2026 ± 723 kg) has produced more than those planted late (1879 ± 703 kg) and their yield was statistically equivalent to that of trees planted early (2025 ± 806 kg).

4.1.3.4 Radial vegetative growth

The mean annual circumference increase ($cm.year^{-1}$) of assay 1 of 2.44 ± 1.29 was satisfactory (Table 3), and significantly influenced by planting time. The annual circumference increment of the control treatment (normal, 2.46 $cm.year^{-1}$) was statistically similar in magnitude to that of planting early (2.49 ± 1.32 $cm.year^{-1}$ and significantly greater than that of late planting treatment (2.37 ± 1.25 $cm.year^{-1}$).

For sub-test 2, the average annual circumference increase (2.27 ± 1.19 $cm.year^{-1}$) of clone GT 1 trees was significantly influenced by the planting date after nine years of experimentation (Table 4). Early-planted trees had an annual increase in circumference (2.43 ± 1.28 $cm.year^{-1}$) statistically higher than late-planted trees (2.03 ± 1.06 $cm.year^{-1}$), and was significantly equivalent at normal treatment (control, 2.37 ± 1.24 $cm.year^{-1}$).

Regardless of the sub-test, the average annual increase in circumference recorded shows that the late-planted rubber trees were negatively affected by the time of planting.

4.1.4 Physiological parameters

The physiological profile whatever the year, the date of planting can be considered as being quite well balanced. The physiological parameters of the first and ninth years of rubber collection of subtests 1 and 2 were largely unaffected by the planting date of clone GT 1 (Tables 5, 6, 7 and 8). Regardless of the planting date of subtests 1 and 2 (early, normal, late), the dry rubber content, generally greater than 50%, was particularly good. In first and ninth year, it did not vary according to treatment or planting date. The average sucrose content of the latex at the beginning and the end of rubber collection (> 8 $mmol.l^{-1}$) was of average level relative to the reference value of this moderate metabolism clone group. Whatever the under test 1 and 2, the date of planting (treatment), the average annual sucrose content of the latex did not change. The average annual inorganic phosphorus content of the latex ($mmol.l^{-1}$) of the experiment was high (> 20). Overall, regardless of the sub-test, the mean annual Pi content of the latex did not distinguish the rubber tree planting dates. The mean annual thiols concentration of the latex ($mmol.l^{-1}$) was average (> 0.60) in first and ninth years of experimental tapping. Overall, regardless of the year of experimentation, the mean annual content of sucrose, inorganic phosphorus and thiols grouping of the latex did not vary according to the date of planting.

Table 5: Physiological profile of clone GT 1 trees subjected to different planting dates (under test 1) after one year of latex harvest.

Treatments	DRC (%)	Suc ($mmol.l^{-1}$)	Pi ($mmol.l^{-1}$)	R-sh ($mmol.l^{-1}$)
Early (22/05/91)	50,58 ± 3,20 a	9,9 ± 2,53 a	19,2 ± 4,13 a	0,63 ± 0,15 a
Normal (co 29/06/91)	50,85 ± 2,13 a	10,3 ± 2,16 a	24,5 ± 3,12 a	0,62 ± 0,16 a
Late (02/09/91)	50,51 ± 3,17 a	9,6 ± 2.16 a	22,27 ± 3,65 a	0,60 ± 0,21 a
Average	50,65 ± 2,83	9,93 ± 2,28	21,99 ± 3,63	0,62 ± 0,17

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). DRC %: Suc ($mmol.l^{-1}$): average sucrose content of the latex expressed in millimoles per liter; Pi ($mmol.l^{-1}$): average inorganic phosphorus content of the latex expressed in millimoles per liter; R-sh ($mmol.l^{-1}$): average content of thiol groups of latex expressed in millimole per liter.

Table 6: Physiological profile of clone GT 1 trees subjected to different planting dates (under test 1) after 9 years of experimentation.

Treatments	DRC (%)	Suc ($mmol.l^{-1}$)	Pi ($mmol.l^{-1}$)	R-sh ($mmol.l^{-1}$)
Early (22/05/91)	52,58 ± 4,27 a	9,15 ± 2,83 a	20,25 ± 4,23 a	0,65 ± 0,17 a
Normal (co 29/06/91)	52,7 ± 4,29 a	10,17 ± 3,15 a	24,99 ± 5,22 a	0,66 ± 0,16 a
Late (02/09/91)	51,8 ± 4,26 a	9,90 ± 3.06 a	23,40 ± 4,65 a	0,63 ± 0,16 a
Average	52,36 ± 4,27	9,74 ± 3,01	22,88 ± 4,7	0,65 ± 0,16

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). DRC %: Suc ($mmol.l^{-1}$): average sucrose content of the latex expressed in millimoles per liter; Pi ($mmol.l^{-1}$): average inorganic phosphorus content of the latex expressed in millimoles per liter; R-sh ($mmol.l^{-1}$): average content of thiol groups of latex expressed in millimole per liter.

Table 7: Physiological profile of clone GT 1 trees subjected to different planting dates (under test 2) after one year of latex harvest.

Treatments	DRC (%)	Suc ($mmol.l^{-1}$)	Pi ($mmol.l^{-1}$)	R-sh ($mmol.l^{-1}$)
Early (22/04/92)	48,7 ± 3,25 a	7,5 ± 0,52 a	19,3 ± 4,43 a	0,59 ± 0,11 a
Normal (co 17/06/92)	51,2 ± 2,45 a	8,0 ± 1,74 a	24,9 ± 4,99 a	0,61 ± 0,09 a
Late (15/10/92)	50,0 ± 3,43 a	7,7 ± 2,04 a	23,0 ± 4,60 a	0,64 ± 0,15 a
Average	49,96 ± 3,04	7,73 ± 1,43	22,4 ± 4,67	0,61 ± 0,12

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). DRC %: Suc ($mmol.l^{-1}$): average sucrose content of the latex expressed in millimoles per liter; Pi ($mmol.l^{-1}$): average inorganic phosphorus content of the latex expressed in millimoles per liter; R-sh ($mmol.l^{-1}$): average content of thiol groups of latex expressed in millimole per liter.

Table 8: Physiological profile of clone GT 1 trees subjected to different planting dates (under test 2) after 9 years of experimentation.

Treatments	DRC (%)	SUC (mmol.l^{-1})	Pi (mmol.l^{-1})	R-sh (mmol.l^{-1})
Early (22/04/92)	52,80 ± 4,45 a	8,15 ± 2,52 a	21,2 ± 4,43 a	0,62 ± 0,16 a
Normal (co 17/06/92)	52,85 ± 4,45 a	8,85 ± 2,74 a	23,88 ± 4,99 a	0,66 ± 0,17 a
Late (15/10/92)	51,52 ± 4,43 a	7,87 ± 2,44 a	22,02 ± 4,60 a	0,67 ± 0,17 a
Average	52,39 ± 4,44	8,29 ± 2,57	22,36 ± 4,67	0,65 ± 0,17

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). DRC %: Suc (mmol.l^{-1}): average sucrose content of the latex expressed in millimoles per liter; Pi (mmol.l^{-1}): average inorganic phosphorus content of the latex expressed in millimoles per liter; R-sh (mmol.l^{-1}): average content of thiol groups of latex expressed in millimole per liter.

4.1.5 Tapping panel dryness

The sensitivity to the tapping panel dryness expressed by the average diseased notch length rates (L E M%) of the subtests 1 and 2 over the 9 years was very low. Levels of L.E.M respectively from 1.75 to 3.07% (Tables 10 and 11) were quite low. The diseased notch length rates were not influenced by the date of planting**.**

5. Discussion

The behavior of trees of the clone GT 1 of *Hevea brasiliensis* is influenced by the timing or date of planting. Trees planted early and at normal times have relatively high live tree, rubber productivity and radial growth rate values compared to those planted late. The delay observed of 6 months in the plantations early or normal, of planting late could not be made up, since planting early and normal has been tapped 6 months earlier than planting late. As the trees of Hevea clone GT 1 of *Hevea brasiliensis* are not at the same date (early, normal and late) and presents different agronomic behaviors, we interpretations of their behavior as a response to seasonal variations of environmental factors, especially climatic. What are the climatic factors? As they noticed Gnanglè *et al*. (2011) [12] the annual water level and rainfall distribution are of great importance in rubber growing. Certain rainfall conditions are essential for trees to provide sufficient vegetative growth and adequate rubber production (Ndoutoumou *et al*., 2017) [17]. The negative effect of low rainfall and its distribution on clone GT 1 is corroborated by the work of Pautasso *et al*. (2010) [27]. These authors have proved that dry periods have the disadvantage of slowing down vegetative growth. They also pose some problems during the year of planting; the seedlings set up in the field must have developed sufficient rooting before undergoing any drought (Compagnon, 1986) [9]. In fact, the dry matter production of plants is correlated with the hydric state of the plant. The results of the nine years of experimentation indicate that diseased notch length (LEM) and physiological profile are not significantly influenced by the date of planting.

Otherwise, the water factor alone cannot explain the level of yield of rubber of the late treatment plants of sub-trials 1 and 2, which benefited from the short rainy season from September to October. The low sun exposure from August to October and the low temperature during the same period would have disrupted the vegetative development of the plants of these dates (02 September and 15 October). These results are consistent with the work (Compagnon, 1986) [9] of who showed that a decrease in insolation is a cause of the fall in the average yield of rubber trees in Malaysia and Côte d'Ivoire. The lack of sunshine has the effect, the reduction of photosynthetic activity, which induces a low accumulation of dry matter (low emergence of the vegetative aerial part), this confirms the observations (Way and Oren, 2010) [30]. In sum, our study indicates that the season favoring the aerial development and the good productivity of the trees then corresponds to the early and normal dates.

6. Conclusion

This study shows that the variation of certain climatic factors has a direct influence on the agronomic characteristics of the rubber tree in the zone considered. In fact, the temperature, the rainfall, and the insolation taken individually explain to varying degrees the variations in yields of the clone observed. The analysis of the variances showing the behavior of the rubber clone GT 1 according to the planting dates, revealed that the rate of trees present in the plots (86.91 ± 0.27%), vegetative growth in tapping (2.36 ± 1.24 cm.year^{-1}) and mean annual yield (2018 ± 763 kg.ha^{-1}.yr^{-1}) were good, and were influenced by the fluctuation of some climatic factors. Despite good rubber productivity, the physiological profile remained good with low LEM (2.41 ± 1.85%), regardless of the date of planting. The proper timing of plantation establishment is early and normal planting.

7. Competing Interests

The authors declare that they have no competing interests.

8. Authors' Contributions

This work was carried out in collaboration between all authors. Authors Ballo Esperence Kouadio, Diarrasouba Moussa and Obouayeba Samuel designed the study, wrote the protocol and wrote the first draft of the manuscript. Ballo Esperence Kouadio and Soumahin Eric Francis reviewed the experimental design and all drafts of the manuscript. Kouadio Yatty Justin, Adou Bini Yao Christophe and Soumahin Eric Francis managed the analysis of the study. Authors Ballo Esperence Kouadio, Soumahin Eric Francis and Obouayeba Samuel collected the study data. Kouadio Yatty Justin and Ballo Esperence Kouadio performed the statistical analysis. All the authors read and approved the final manuscript.

Table 9: References values of the most important physiological parameters of the latex (acob et al., 1987).

Very high	>43	>12	>25	>0.90
High	38 to 43	9 to 12	20 to 25	0.80 to 0.90
Medium	33 to 38	6 to 9	15 to 20	0.60 to 0.80
Low	29 to 33	4 to 6	10 to 15	0.50 to 0.60
Very low	≤29	≤4	≤10	≤0.50

Table 10: Percentage dryness sensitivity of clone GT 1 subjected to different planting dates (Under test 1) after nine years of experimentation.

Treatments	LEM (%)
Early (22/04/92)	1,70 ± 1,3 a
Normal co (17/06/92)	1,62 ± 1,24 a
Late (15/10/92)	1,93 ± 1,48 a
Average	1,75 ± 1,34

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). LEM: diseased notch length

Table 11: Percentage dryness sensitivity of clone GT 1 subjected to different planting dates (Under test 2) after nine years of experimentation.

Treatments	LEM (%)
Early (22/04/91)	2,89 ± 2,22 a
Normal co (17/06/91)	3,03 ± 2,33 a
Latef (15/10/91)	3,29 ± 2,53 a
Average	3,07 ± 2,36

In the same column, averages followed by the same letter are not significantly different (Newmann-Keuls test at 5%). LEM: diseased notch length.

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