1

SOME CONSIDERATIONS CONCERNING THE PANEL MANAGEMENT IN RUBBER TAPPING (*HEVEA BRASILIENSIS*)

R. Lacote*, O. Gabla**, S. Obouayeba***, E. Gohet*, A. Doumbia**, M. Gnagne*** and J.M. Eschbach*

*: Cirad, UR 34, Tree Crop Based Systems, TA80/B2, 34398 Montpellier, France
**: Hevego, Rubber Research Station BP 793, San Pedro, Côte d'Ivoire
***: CNRA, 01 BP 1536 Abidjan O1, Côte d'Ivoire

Corresponding author: R. Lacote, regis.lacote@cirad.fr

ABSTRACT

Research devoted to long term panel management deserved less efforts, mainly due to the long duration required for experimentation. The present study deals with the comparison of two panel management strategies on nine clones tapped in 1/2S, over a total period of nine years, in Côte d'Ivoire: annual panel changing and no panel changing. Four IRCA clones were compared to PB 330, GT 1, PB 217 et PB 260. For all clones, panel management influenced the annual yield. During the first six years, panel changing was more favourable to yield. After nine years, however, the cumulative rubber yield did not vary with panel strategy. Only clone IRCA 111 showed a significant higher yield with no panel changing. Authors recommend a panel changing strategy based on physiological fatigue of the tapping panel. The aim is to sustain the yield potential of the trunk and to reduce the tapping panel dryness occurrence during the downward tapping period.

Keywords: *Hevea brasiliensis*, tapping, panel management, latex yield, tapping-panel dryness (TPD).

INTRODUCTION

The management of the bark consumption is one component of the tapping system technology; many research and development efforts have been applied to it in order to maximize land and labour productivities, taking into account the socio-economic context of each production area. After the discovery of stimulation by ethephon, most of the elements of the tapping systems, such as the tapping-cut length, the tapping frequency, or the fine-tuning of stimulation itself, had to be adapted in conjunction with this major innovation.

In Malaysia, with a ½ S d/2, hormonal stimulation led to a reduction of the tapping intensity with daily alternate ¼ S d/2 or d/4 (Abraham, 1970). Then these daily panel changes were recommended to smallholders (Abraham and Anthony, 1980, Sivakumaran and Pakianathan, 1983) or in some regions with important rainfall and where tapping frequency was still irregular (Husin and Abraham, 1984). In Côte d'Ivoire, the use of the stimulation led to the reduction of the tapping intensity from S d/3 to ½ S d/3 (Eschbach et al., 1985). Several panel changing frequencies were studied. High yield were obtained with panel changing at each tapping or at each climatic season in the year (Anon, 1984). These results were recently confirmed in Thailand (Gohet and Chantuma, 2003).

The tapping system technology has been subjected to in-depth research devoted to the physiology of the laticifer tissue; this led to the development of the latex diagnosis and of the concept of clonal metabolic typology (Commère et al, 1991). Panel changing is generally considered as useful for reducing the physiological stress generated to a panel by tapping. For GT 1, a higher production is accompanied by a smaller percentage of bark dryness when tapping is located below an older regenerated bark zone than below a zone in course of regeneration (Eschbach et al., 1986). As a matter of fact, panel changing after the first two tapping-years has been generalized in Côte d'Ivoire

Research devoted to long term panel management deserved less efforts, mainly due to the long duration required for experimentation. In Cameroon, no difference were observed on yield of clones GT 1 and PR 107 between annual panel changing and no panel change during 7 years of experiment (Anon 1996). In Indonesia, no differences were observed on yield after four years of tapping for the clone PB 260. (Gohet pers com.). Conversely, in Cameroon, the non alternate ½ S was producing more than an alternate tapping (Anon 1994). Lacote et al (2004) showed that panel management did not influence the total yield after nine years of tapping. But they showed that annual yield and latex cells physiology were strongly influenced by panel management. Therefore they proposed to monitor panel management with the use of latex diagnosis.

A series of trials was set up in order to make possible the adaptation of panel management to IRCA clones compared to some others well known clones as PB 330, GT 1, PB 217 and PB 260. The present study deals with the comparison of two panel management strategies over a total period of nine years: changing and no changing. The objective is to compare the impact of these strategies on the annual and cumulated yields, as well as on the occurrence of TPD. As a matter of fact, it has been shown that panel changing do not prevent apparition of TPD (Lacote et al., 2004) but could be responsible for a faster development of this TPD (Eschbach et al., 1994, Krishnakumar et al., 2002).

METHODS

Plant Material

Nine clones were studied in nine different experiments in the Hévégo research station located in the south-west of Côte d'Ivoire. Clones display the main different types which can be met in the clonal typology of the laticiferous metabolism (Serres et al., 1988, Eschbach, 1989, Gohet and Chantuma, 2003). Within this framework, IRCA 111, IRCA 130, PB 330 and PB 260 are considered as active clones. IRCA 109, IRCA 18 and GT 1, display a medium laticiferous metabolism. PB 217 and PR 107 can be activated by intensive stimulation (Serres et al., 1988).

In the nine trials, the trees were opened at the standard girth of the trunk of 50 cm measured at 1.0 m high, on panel B0.1, and at 1.20 m above ground level. The tapping system was ½ S d/4 6d/7 12m/12 ET 2.5 % Pa 1(1). The stimulation frequency applied to the clones IRCA 111, IRCA 18 and PB 260 was 6/y. The stimulation frequency applied to the clones IRCA 109, IRCA 130, PB 330 and GT 1, was 8/y. The stimulation frequency applied to the clones PB 217 and PR 107 was 10/y.

Measurements and Data Processing

The experimental design was a « one-tree plot design » with 33 trees per treatment and a total randomization of all the trees in a plot. Trees with equal size were selected at the beginning of each trial. The panel management is shown figure 1. For measuring latex yield per tree, cumulated coagulated rubber of each tree was weighed every four weeks and total solid content was measured from a bulk sample taken in each treatment in order to convert fresh weights in grams of dry rubber per tree. The girths of the trees were measured every year at 1.70 m above ground level. TPD was assessed by counting the percentage of dry trees (TPD) and estimating visually the percentage of dry-cut length (% DCL) on each tree (16). Statistical analysis of latex yields was carried out by using the SAS statistical software; the Student-Newman-Keuls test with alpha threshold of 0.05 was used (SAS/status 1988).

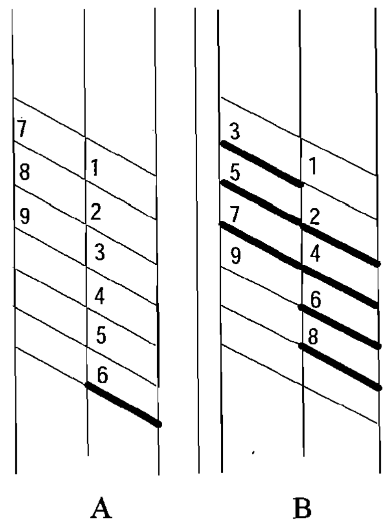

Fig. 1 The two panel management systems.
A: no panel change (1PC) on panel BO-1 and BO-2 opened in year 7 at 1,4 m;
B: annual panel change after two years on BO-1, i.e. seven panel changes (7PC) after 2, 3, 4, 5, 6, 7 and 8 years.

In order to standardize the variations between the two treatments and within each trial, the yield and girth data were transformed into indexes, with index 100 systematically attributed to the treatment A.

RESULTS

Latex yield

Table 1 shows the annual yield of the nine clones. The average yield of all clones increased along the three year of tapping with annual panel changing (*Treatment B*). Then yield was stable along the six next years. With no panel change (*Treatment A*), yield was decreasing after the fourth year to the sixth year. Changing the panel in year seven induced a significant higher yield, reaching 6.7 Kg per tree (Figure 2a). Then, in years eight and nine, yield was around 6 Kg per tree per year.

Table 2 shows the cumulative yield of all clones. After six years, the yield increase of T*reatment B* over *Treatment A* was 16 %. After a nine tapping period, the cumulative yield of *Treatment B* was equivalent to *Treatment A* (Figure 2b).

Table 1 Annual yield (Kg/tree) according to panel changing frequency for each clone. Mean affected by the same letter are not significant.

Clone	Treatment	Year of tapping								
		1	2	3	4	5	6	7	8	9
Irca 109	No panel changing	3,85	5,54	5,05 b	3,41 b	4,78 b	3,72 b	8,49 a	6,03 a	7,16 a
	Annual panel changing	3,87	5,94	7,09 a	4,18 a	5,90 a	4,97 a	5,74 b	4,63 b	5,66 b
Irca111	No panel changing	3,36	4,38	5,14	4,44	4,70 b	3,83	6,30 a	5,65 a	5,59 a
	Annual panel changing	3,37	4,31	5,22	4,51	5,32 a	3,97	4,74 b	3,36 b	4,31 b
Irca 18	No panel changing	5,01	5,78	4,05 b	5,86 b	4,48 b	3,51 b	6,41 a	5,34 a	5,98
	Annual panel changing	5,27	5,88	5,42 a	6,40 a	5,11 a	5,80 a	4,33 b	4,69 b	5,53
Irca 130	No panel changing	5,02	4,45	4,03	3,92	2,85 b	2,45 b	5,56 a	4,68	3,95 a
	Annual panel changing	4,75	4,31	4,40	3,79	3,54 a	3,72 a	3,51 b	4,32	3,42 b
PB 330	No panel changing	2,87	3,68	3,78 b	4,52	3,17 b	2,89 b	6,66 a	7,93 a	6,23 a
	Annual panel changing	3,00	3,78	5,89 a	4,93	4,14 a	4,03 a	4,91 b	5,67 b	4,79 b
PR 107	No panel changing	2,59	2,80	4,23	3,42 b	3,05 b	2,59 b	4,14	4,32	4,90
	Annual panel changing	2,58	2,64	4,04	4,15 a	3,49 a	3,35 a	3,78	4,28	4,00
GT 1	No panel changing	2,60	2,92 b	3,58 b	3,27 b	2,93 b	3,28 b	5,74 a	3,99 a	5,47 a
	Annual panel changing	2,80	3,23 a	4,24 a	4,12 a	3,85 a	4,20 a	3,72 b	2,94 b	3,62 b
PB 217	No panel changing	3,01	3,04	3,74 b	3,47 b	4,58 b	4,05 b	7,64 a	7,85 a	9,21
	Annual panel changing	3,05	3,00	4,22 a	4,04 a	5,89 a	6,08 a	6,24 b	5,35 b	8,42
PB 260	No panel changing	3,67	4,35	4,43 b	5,78 b	4,54 b	3,67 b	9,51 a	7,15 a	6,91 a
	Annual panel changing	3,83	4,60	5,36 a	6,33 a	6,11 a	6,28 a	5,06 b	5,34 b	5,91 b
Average	No panel changing	3,55	4,10	4,23	4,23	3,90	3,34	6,72 a	5,89	6,16
	Annual panel changing	3,61	4,19	5,10	4,72	4,82	4,71	4,67 b	4,51	5,08

Table 2 Cumulated yield (Kg/tree) according to panel changing frequency for each clone. Mean affected by the same letter are not significant.

Clone	Treatment	Year of tapping								
		1	2	3	4	5	6	7	8	9
Irca 109	No panel changing	3,85	9,39	14,43 b	17,85 b	22,63 b	26,35 b	34,85 b	40,89	48,05
	Annual panel changing	3,87	9,81	16,90 a	21,08 a	26,99 a	31,96 a	37,70 a	42,33	48,00
Irca111	No panel changing	3,36	7,74	12,88	17,31	22,02	25,85	32,16	37,82	43,42
	Annual panel changing	3,37	7,68	12,90	17,41	22,74	26,71	31,45	34,82	39,14
Irca 18	No panel changing	5,01	10,79	14,8 b	20,70 b	25,18 b	28,70 b	35,11	40,45	46,43
	Annual panel changing	5,27	11,15	16,6 a	22,97 a	28,09 a	33,89 a	38,22	42,91	48,44
Irca 130	No panel changing	5,02	9,47	13,51	17,43	20,28	22,73	28,30	32,98	36,94
	Annual panel changing	4,75	9,06	13,46	17,25	20,80	24,52	28,03	32,35	35,77
PB 330	No panel changing	2,87	6,55	10,34 b	14,86 b	18,04 b	20,93 b	27,59 b	35,52	41,76
	Annual panel changing	3,00	6,78	12,67 a	17,60 a	21,74 a	25,77 a	30,69 a	36,36	41,16
PR 107	No panel changing	2,59	5,39	9,62	13,04	16,09	18,68 b	22,82 b	27,15	32,04
	Annual panel changing	2,58	5,22	9,26	13,42	16,91	20,27 a	24,05 a	28,32	32,33
GT 1	No panel changing	2,60	5,5 b	9,10 b	12,36 b	15,30 b	18,59 b	24,33 b	28,32	33,80
	Annual panel changing	2,80	6,0 a	10,27 a	14,39 a	18,25 a	22,4 a	26,18 a	29,12	32,75
PB 217	No panel changing	3,01	6,05	9,79	13,26 b	17,85 b	21,90 b	29,54 b	37,39	46,60
	Annual panel changing	3,05	6,05	10,27	14,30 a	20,20 a	26,28 a	32,52 a	37,88	46,30
PB 260	No panel changing	3,67	8,02	12,45 b	18,23 b	22,77 b	26,44 b	35,96	43,11	50,03
	Annual panel changing	3,83	8,43	13,79 a	20,12 a	26,23 a	32,52 a	37,58	42,93	48,84
Average	No panel changing	3,55	7,66	11,88	16,11	20,02	23,35 b	30,07	35,96	42,12
	Annual panel changing	3,61	7,80	12,90	17,62	22,44	27,15 a	31,83	36,34	41,41

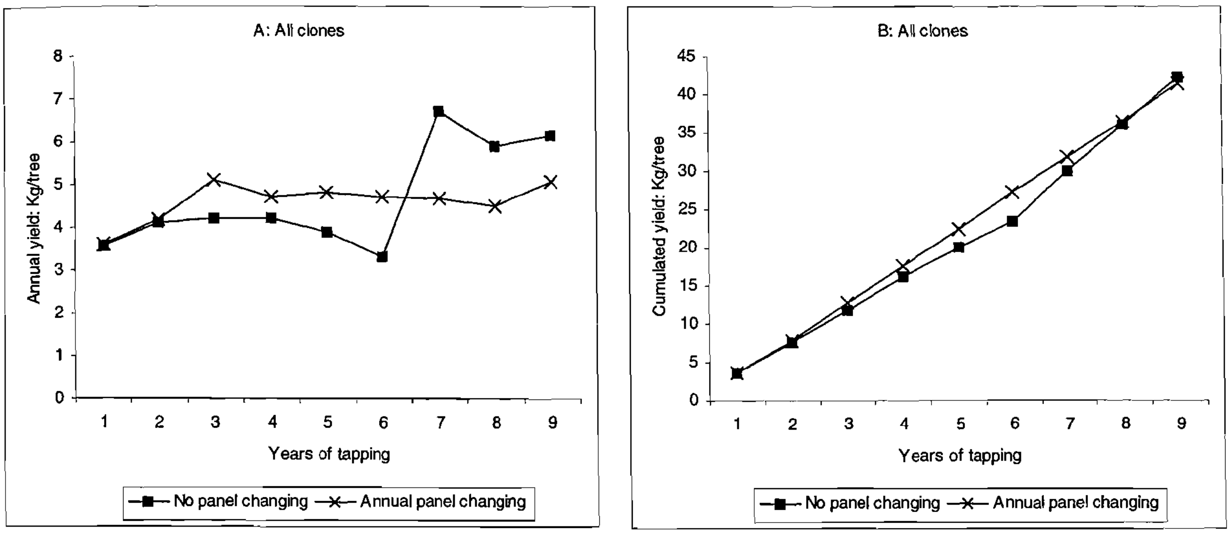

Fig. 2 Annual and cumulated yield according to panel management. Mean of all clones

For each clone, management strongly influenced annual yield. For clones PB 330, PR 107, PB 260, IRCA 109 and IRCA 18, annual yield was continuously decreasing after the third or fourth year to the sixth year, for *Treatment A* (Figures 3a, 4a, 5a, 6a and 7a) This trend was less pronounced for clones GT 1 and IRCA 111 (Figures 8a and 9a). Clone IRCA 130 showed a continuous decline of the yield with *Treatment A* (Figure 10a). On the contrary, clone PB 217 showed a regular yield increase along the six years (Figure 11a). The main significant difference between the two treatments was observed from the year three to year six for all clones when the panel changing strategy began for *Treatment A* (Table 1). Only clone IRCA 111 showed a different pattern with equivalent annual yield until the sixth year (Figure 7a).
For each clone the first opening of the opposite panel in the seventh year produced a high yield (Table 1, Figures 3a to 11a). After nine years of tapping cumulative yield of *Treatment A* was equivalent to *Treatment B* (Table 2, Fig. 3b to 11b). Only clone IRCA 111 showed a higher cumulative yield with *Treatment A*.

Girth increments

Table 3 shows the trunk circumference of clones according to the tapping panel changing frequency. At a general trend, the circumference of the trees for treatment A was higher than that of treatment B. It was only significant for clones PB 330, PR 107, GT 1 and PB 217. For 9 years of tapping, there was no difference between the two treatments excepted for PB 330: for this clone, circumference of trees for *Treatment A* was higher than that of *Treatments B*.

Yield and girth increment relationship

In most cases, high production indexes were associated with low girth increment indexes, and vice versa. Figure 12a shows the significant negative relationship (with alpha threshold of 0.05) between the 81 yield indexes and the 81 trunk girth increment indexes (df = 79, r = -0,683).

Figure 12b shows the relation between trunk girth after 6 years of tapping (G6), and the cumulative yield of the following third tapping period (Y7-9) for the two treatments and for the nine clones (df = 7, r = -0,77). G6 and of Y7-9 were strongly correlated. This relationship is mainly due to the difference between *Treatment A* and *Treatment B* for PB 330, PR 107, GT 1 and PB 217. In these cases, the higher the trunk girth after 6 years, the higher the yield in the next tapping period.

Table 3 Trunk circumference according to panel changing frequency for each clone. Mean affected by the same letter are not significant.

Clone	Treatment	Year of tapping								
		1	2	3	4	5	6	7	8	9
Irca 109	No panel changing	54,3	59,6	62,8	65,2	68,9	72,7	74,6	75,4	76,7
	Annual panel changing	54,3	59,5	61,9	64,1	67,1	70,2	72,7	74,2	75,6
Irca111	No panel changing	55,5	57,7	61,5	65,8	68,6	71,8	73,5	76,4	77,6
	Annual panel changing	56,0	58,1	62,3	66,2	68,2	70,5	72,8	75,9	77,3
Irca 18	No panel changing	53,3	56,4	59,7	62,7	65,6	69,7	71,8	74,0	75,5
	Annual panel changing	53,8	57,0	60,2	63,6	65,8	69,2	70,9	73,8	75,8
Irca 130	No panel changing	51,6	53,6	56	58,5	61,9	64,5	65,5	67,1	69,2
	Annual panel changing	51,9	53,7	55,9	58,8	61,4	63,5	66,4	68,3	70,2
PB 330	No panel changing	51,6	54,3	57,9	63	68,6 a	72,8 a	75,5 a	76,5 a	77,7 a
	Annual panel changing	52,1	55,1	57,8	62,6	66,2 b	69,2 b	71,7 b	72,9 b	74,8 b
PR 107	No panel changing	51,6	53,6	58,4	61,4	64,8 a	67,9 a	69,1	70,7	71,7
	Annual panel changing	51,6	53,4	58,0	60,1	62,6 b	65,6 b	67,2	69,0	70,8
GT 1	No panel changing	50,4	52,4	55,0	58,5	61,0	63,6 a	64,5	67,1	68
	Annual panel changing	50,7	52,8	55,0	57,9	59,4	61,4 b	63,2	65,9	67,1
PB 217	No panel changing	52,6	61,6	62,5	66,9	69,9	74,2 a	75,9	78,8	80,5
	Annual panel changing	53,0	61,5	62,3	66,6	69,0	71,8 b	74,2	77,4	79,2
PB 260	No panel changing	53,0	55,9	59,5	63,0	65,6	69,5	70,5	71,5	73,5
	Annual panel changing	53,6	56,8	59,7	63,2	64,8	68,0	69,6	71,1	73,5
Average	No panel changing	52,66	56,12	59,26	62,78	65,93	69,64	70,68	72,63	74,09
	Annual panel changing	53,00	56,43	59,23	62,57	65,10	68,28	69,63	71,95	73,69

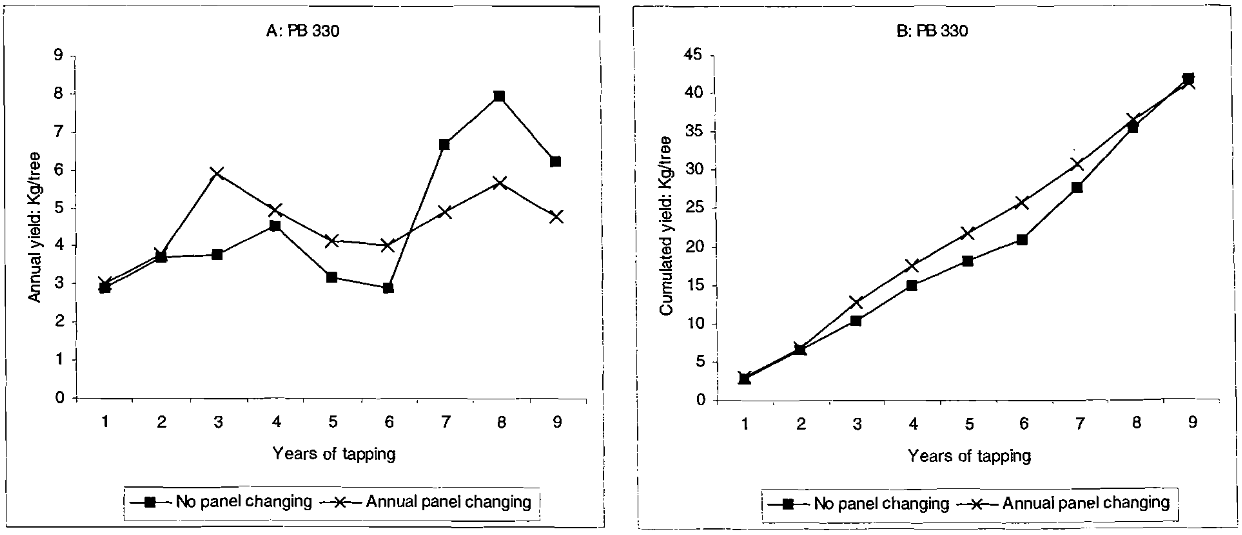

Fig. 3 Annual (A) and cumulated (B) yield according to panel management for clone PB 330

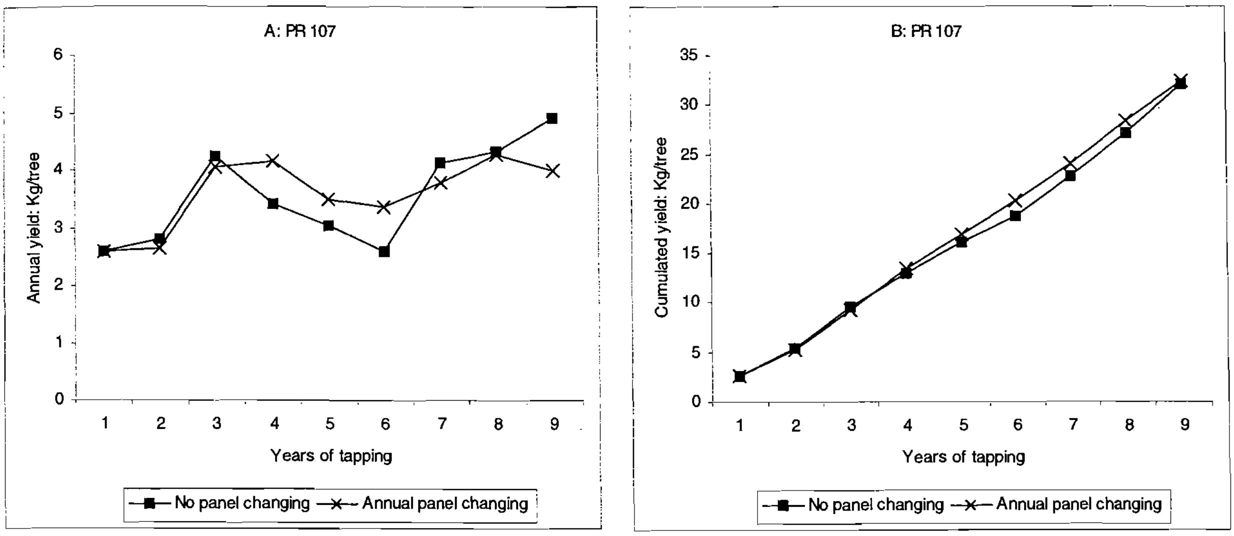

Fig. 4 Annual (A) and cumulated (B) yield according to panel management for clone PR 107

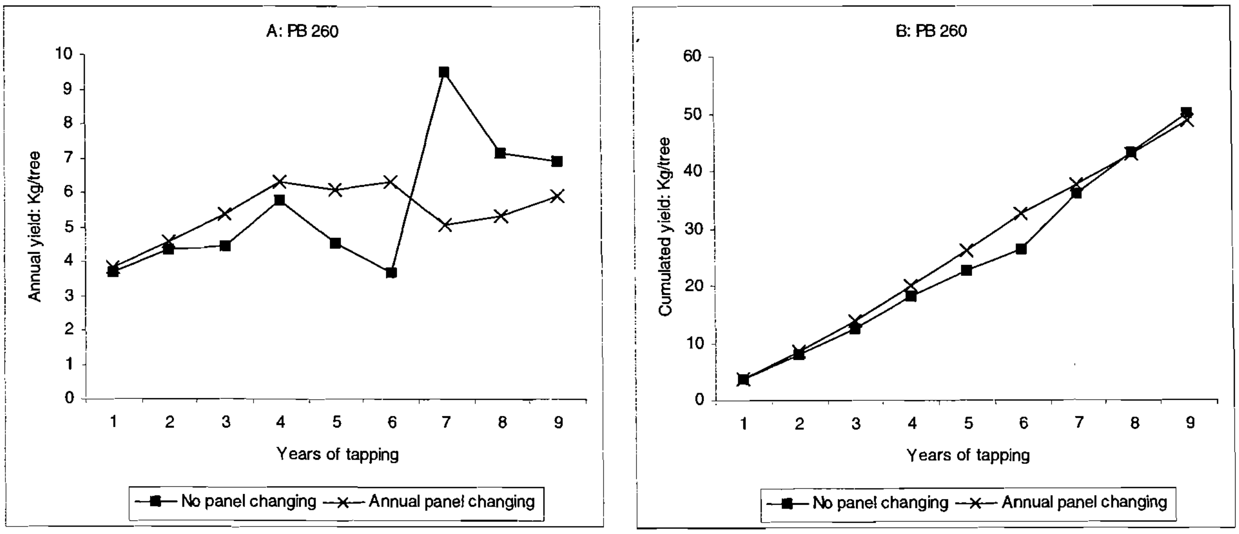

Fig. 5 Annual (A) and cumulated (B) yield according to panel management for clone PB 260

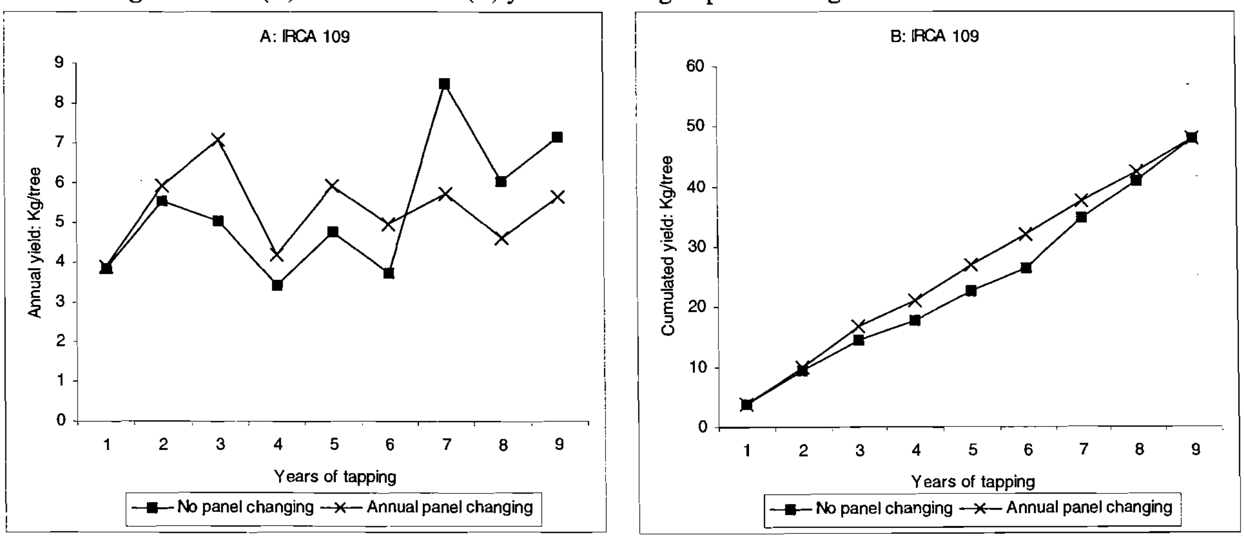

Fig. 6 Annual (A) and cumulated (B) yield according to panel management for clone IRCA 109

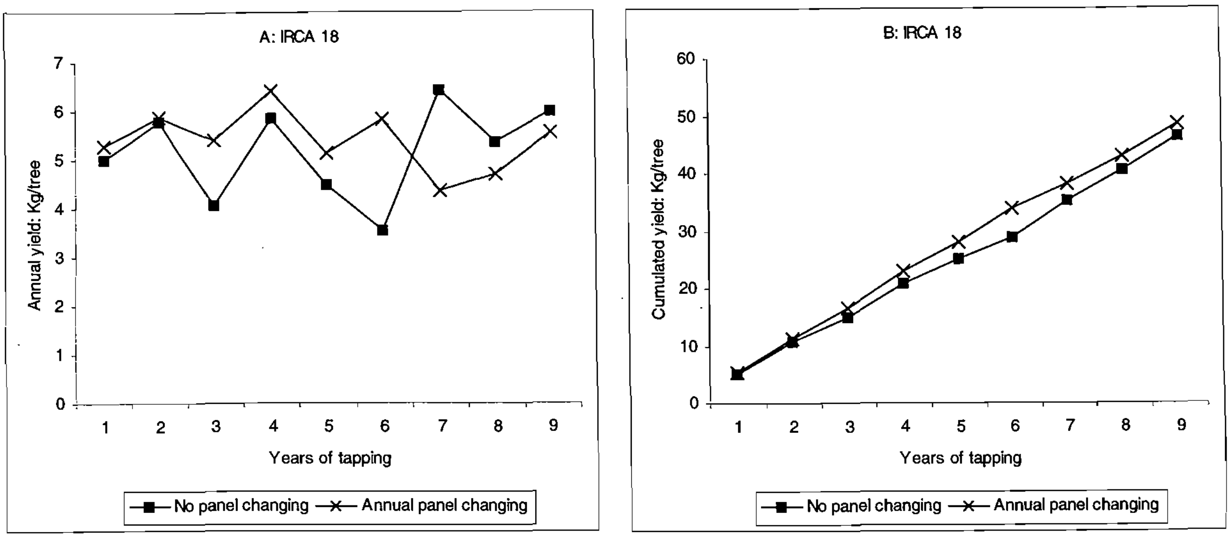

Fig. 7 Annual (A) and cumulated (B) yield according to panel management for clone IRCA 18

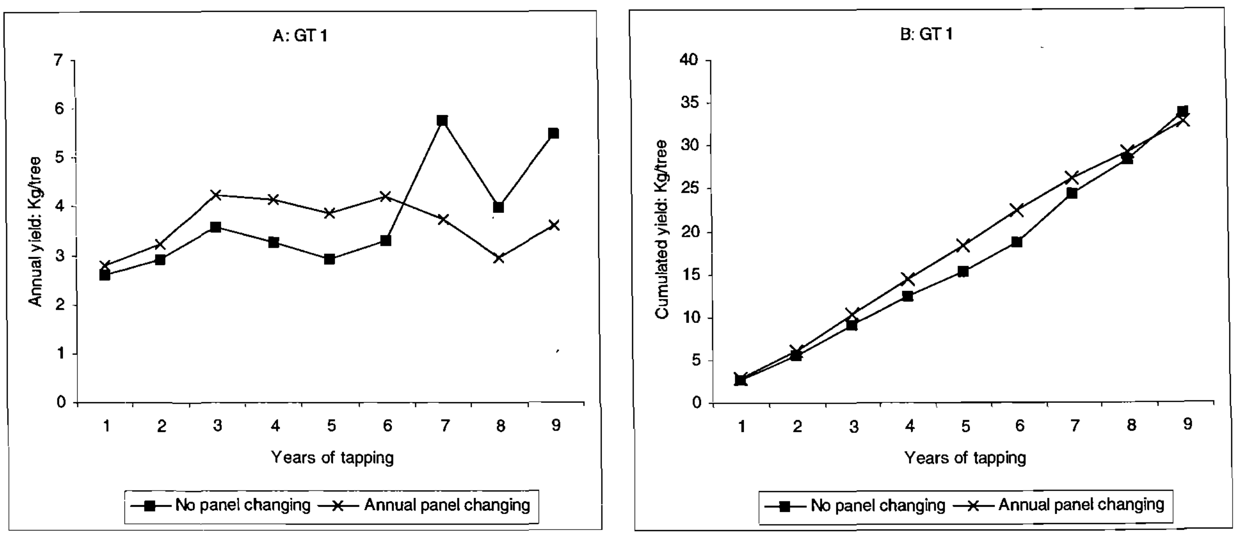

Fig. 8 Annual (A) and cumulated (B) yield according to panel management for clone GT 1

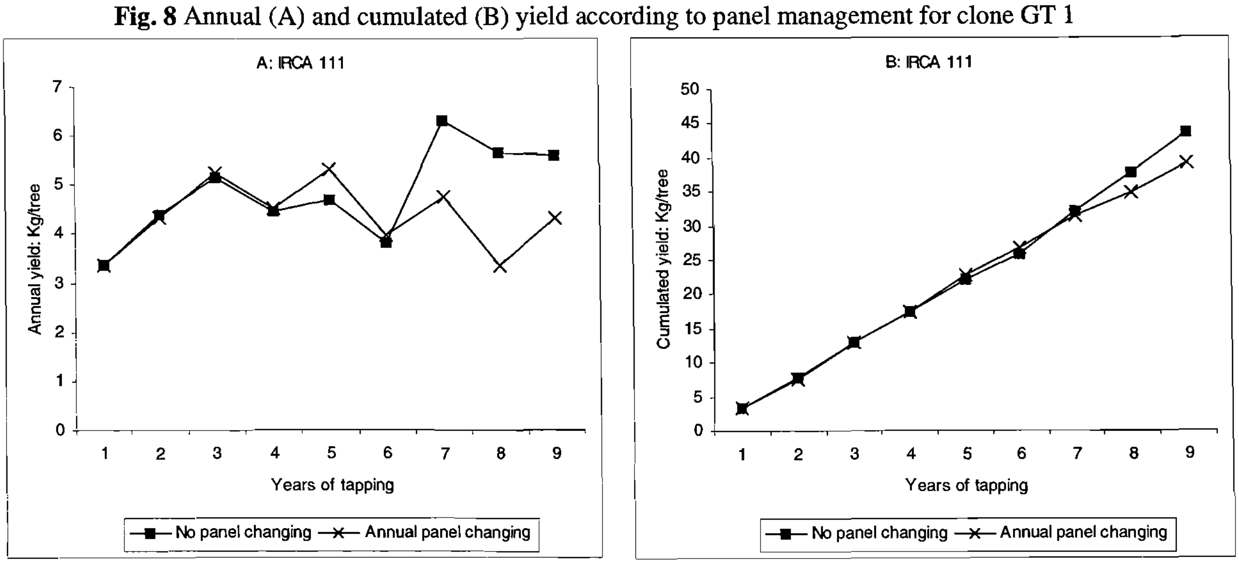

Fig. 9 Annual (A) and cumulated (B) yield according to panel management for clone IRCA 111

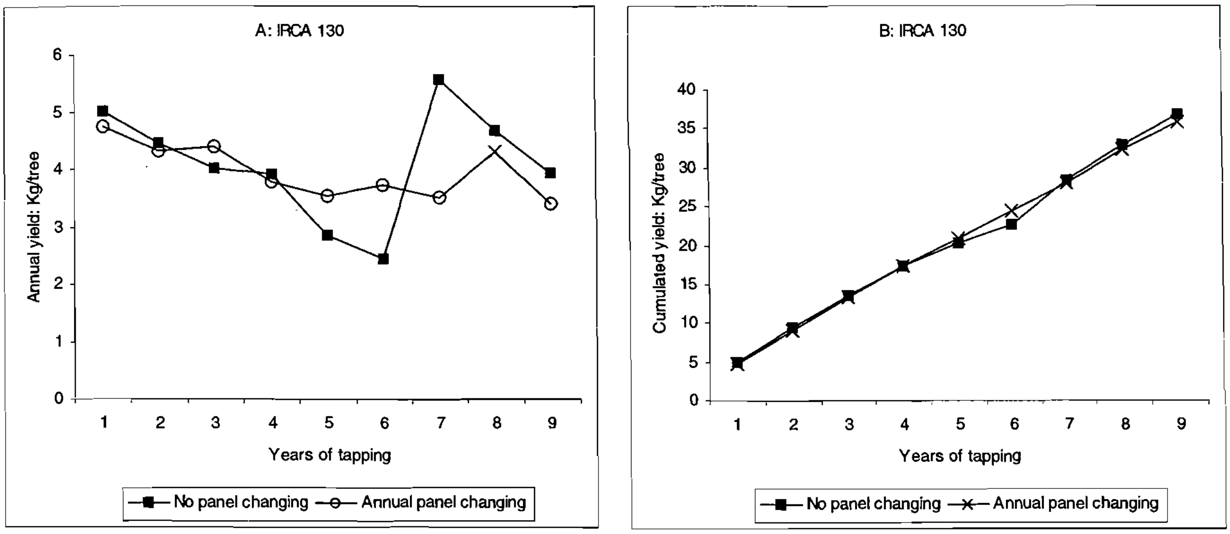

Fig. 10 Annual (A) and cumulated (B) yield according to panel management for clone IRCA 130

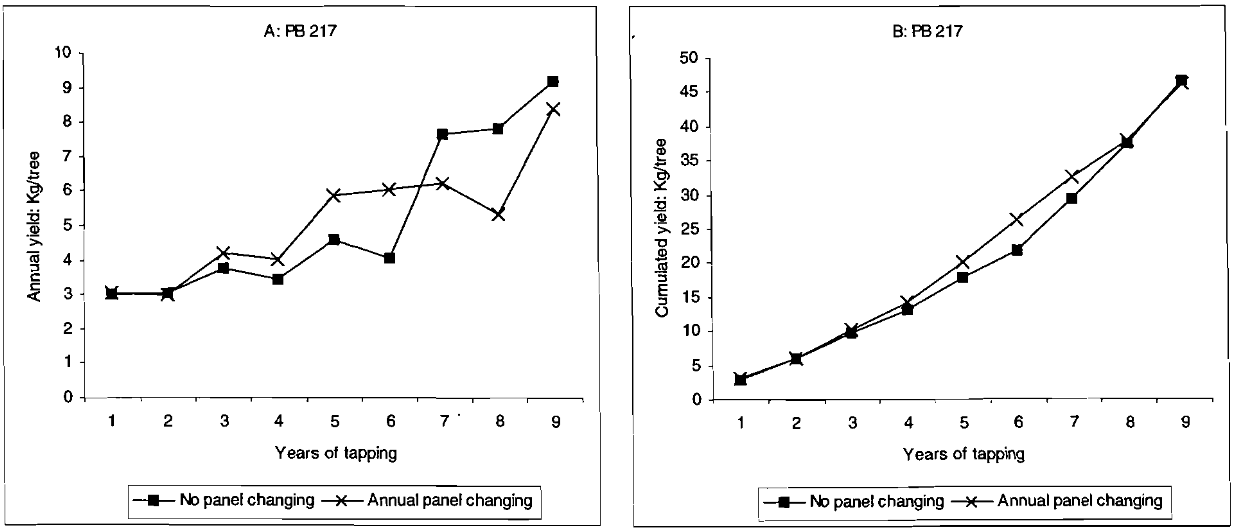

Fig. 11 Annual (A) and cumulated (B) yield according to panel management for clone PB 217

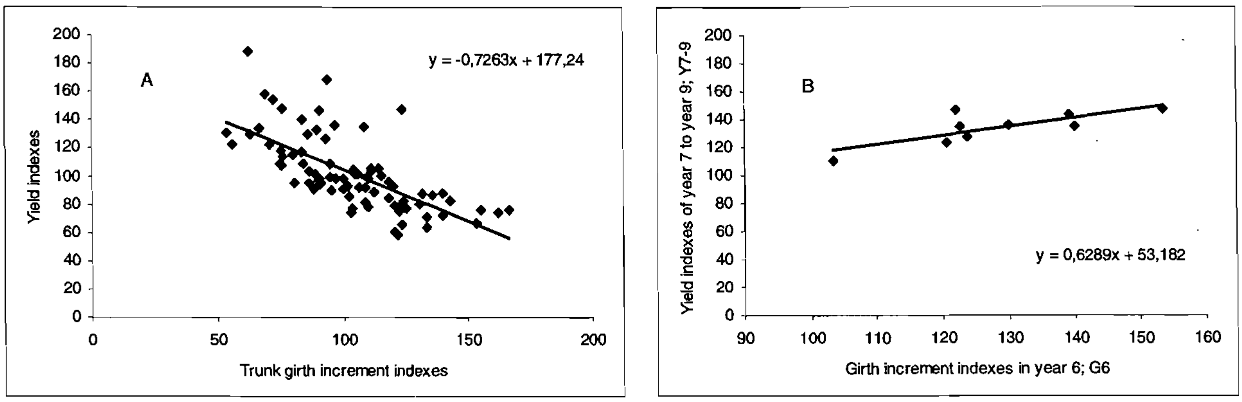

Fig. 12 Relationship between yield and girth increment (A), and relationship between girth increment after 6 years of tapping and the cumulative yield index of the third tapping period (Y7-9) for the two treatments and the nine clones (B). Index 100 is assigned to treatment A.

Tapping panel dryness

The dry cut length was low for all clones after nine years of tapping (table 4). Clones are more or less susceptible to panel changing. IRCA 109, IRCA 130 and PB 217 had a higher dry cut length with no panel changing, after the three last years on panel B0-2. Conversely, for clones IRCA 111 and B 260, annual panel changing has induced more panel dryness incidence.

Table 4 Dry curt length (%) according to panel changing frequency for each clone

Clone	Clone	Treatment	Year 9
Irca 109	Irca 109	No panel changing	4,2
		Annual panel changing	0,0
Irca111	Irca111	No panel changing	0,4
		Annual panel changing	8,6
Irca 18	Irca 18	No panel changing	0,0
		Annual panel changing	2,4
Irca 130	Irca 130	No panel changing	8,3
		Annual panel changing	5,3
PB 330	PB 330	No panel changing	0,0
		Annual panel changing	2,8
PR 107	PR 107	No panel changing	0,0
		Annual panel changing	0,4
GT 1	GT 1	No panel changing	0,0
		Annual panel changing	0,0
PB 217	PB 217	No panel changing	5,4
		Annual panel changing	0,0
PB 260	PB 260	No panel changing	2,6
		Annual panel changing	5,5

DISCUSSION

After two years, yields of the two treatments are equivalent with no panel change. At the third year, the first panel change induced a higher yield than no change for most of the clones. Hence, the cumulative yield of *Treatment B* was higher than yield of *Treatment A*. Only clones PB 217, IRCA 111, IRCA 130 and PR 107 did not showed a significant difference between the two treatments.

After six years, the cumulative yield was higher for *Treatment B* than for *Treatment A*. At that period, *Treatment B* had involved four panel changes, whereas *Treatment A* had none. In between three and six years, for no panel change, for most of the clones tested, yield did decrease, or at least, did not increase. That phenomenon was usually observed. It could be due to the reduction of the drainage area, the influence of the scion and the physiological fatigue of the latex cell (Lacote et al., 2004). During the same time, yield obtained with annual panel change was the highest. This main difference with *Treatment A* was the location of the tapping cut on the trunk, more far from the scion. Tapping cut was located upper on the panel, and the physiological status of the drainage area was more favourable to yield with a less extent of tapping panel dryness (Eschbach et al., 1994, Krishnakumar and Jacob, 2002, Lacote et al., 2004).

For the same physiological reasons, and after nine years of tapping, the difference between treatments was reduced to nil or even inverted in the case of clone IRCA 111. That inversion can be explained by the high yield obtained by *Treatment A* on the newly opened panel B0-2 during the last tapping period: year seven to nine. Panel change at the seventh year has replaced the tapping cut at the top of the panel under a virgin bark. That change has provided the most favourable physiological conditions to yield (Eschbach et al., 1986, Eschbach et al, 1994, Krishnakumar and Jacob, 2002, Lacote et al, 2004). The yield of this tapping cut was significantly higher than the yield of the tapping cut of the *Treatment B* located under a regenerated bark of two years old.

Clones were susceptible to the continuous downward taping on the same panel. Yield was decreasing from year three to year six. Clone PB 217, with a lower latex cells metabolism, was less susceptible to continuous downward tapping.

Yield depends on the position of the cut on the trunk and also of the age of the regenerated bark above the tapping cut. Longer is that time for bark regeneration, better is the physiology of the latex cells and higher will be the yield (Eschbach et al;, 1986). During the first years of tapping with annual panel changing, yield will be higher. Conversely, without any panel changing during the first years on panel B0-1, yield of the panel B0-2 will be always higher. Panel strategy must consider that point on a long term tapping period.

A right panel strategy, adapted to most of clones, could be tapping without any panel change unless yield decreases sharply. In that case, if conditions for tapping are fine, regarding climatic effect or pathological diseases, it could be envisaged to increase yield again while changing the panel to locate the tapping cut on the trunk under more favourable conditions to yield. Latex diagnosis is the right tool to evaluate the physiological status on the trunk and help to drive the panel management (Lacote et al, 2004).

CONCLUSION

The two panel management strategies differed in the number of panel changes and the position of the tapping cut on each panel, over a nine year period of tapping. IRCA clones showed the same behaviour than other PB clones and GT 1. Treatment with a maximum number of panel changes achieved a higher cumulative yield after six years than the treatment with only one panel change. That advantage was reduced to nil after nine years, or even inverted for clone IRCA 111. Minimizing the number of panel change did not decrease the cumulative yield.

No panel change would be more simple and cost-effective. A continuous downward tapping is recommended without alternating, unless a sharp drop in yield and/or a damaged physiological status (LD) is/are observed.

The tapping panel strategy depends on the climatic, physical, economical and social conditions of the rubber plantation. Moreover, it depends on the physiology of the latex cells, hence, on the yield potential of the drainage area. The Diagnostic Latex is the right tool to drive that strategy.

Acknowledgement

This study was supported by the Hevego S.A., Société Hévéicole du Go, San Pedro Côte d'Ivoire. Thanks are due to director, Mr K. Konaté, specialists, and assistants.

REFERENCES

Abraham, P. D. (1970) "Field trials with Ethrel." *Planters' Bull.*: 366.Abraham, P. D. and J. L. Anthony (1980). "Exploitation procedures for mature rubber of smallholdings." Planters' Bulletin of the Rubber Research Institute of Malaysia (164): 132-141.

Anon. (1984) Recherche de systèmes de saignée adaptés aux clones. IRCA Annual Report 1984. pp 75-79.

Anon. (1994) Essai de saignée en descente continue. HEVECAM. Annual Report. III. 25.

Anon (1996). Effet du balancement de panneau annuel sur la production du clone GT 1. NRRP/IRAD.Annual Report. pp 11.

Commère, J., E. Serres, and Lacrotte R. (1991) Yield potential for the clones PB 235 and PB 217 tapped with 1/2 S d/4 6d/7 for the first 3 years after opening in the Sout East of Côte d'Ivoire. IRRDB Symposium; 1990/10/06-07; Kunming (CHN), Brickendonbury (GBR) : IRRDB, 1991. 93-102.

Eschbach, J. M. and Y. Banchi (1985) Advantages of Ethrel stimulation in Association with reduced tapping intensity in the Ivory Cost -. Planter (MYS), 1985/12. - vol. 61, n. 717, p. 555-567 : 11 réf., 4 tabl., 4 graph. - inter.: S.

Eschbach, J. M., Tupy, J., and Lacrotte, R. (1986) Photosynthetate allocation and productivity of latex vessels in Hevea Brasiliensis. Biol. Plant., (28): 321.

Eschbach, J. M. and R. Lacrotte (1989) Factors influencing response to hormonal yield stimulation: limits of this stimulation , Boca Raton (USA) : CRC Press, 1989, pp. 321-331.

Eschbach, J. M., Hasibuan, S. E., and James, A. Q. (1994) Clonal influence of panel management on bark necrosis. Workshop on tapping panel dryness of Hevea, 26-28 July 1994, Hainan. In: "IRRDB, Proceedings of workshop on tapping panel dryness of Hevea", pp. 17-21.

Gohet, E. and P. Chantuma (2003) Double cut alternative tapping system (DCA) : towards improvement of yield an labour productivity of Thailand rubber smallholdings. International Rubber Workshop on Exploitation Physiology, Kottayam, India, 2003, 43-72. Vijayakumar K.R., Thomas K.U., Rajagopal R., Karunaichamy K. eds., Kottayam, India, Rubber Research Institute of India.

Husin, S. M., P. D. Abraham (1984) Exploitation systems in regions experiencing heavy seasonal rainfall. Proceedings of the symposium "Exploitation, physiology and improvement of Hevea". Paris, France, Irca-Gerdat.

Jacob, J.-L., Prévôt, J.-C., Roussel, D., Lacrotte, R., Serres, E., d'Auzac, J., Eschbach, J.-M., and Omont, H. (1989) Yield-limiting factors, latex physiological parameters, latex diagnosis, and clonal typology. In: "Physiology of Rubber Tree Latex" (J. d'Auzac, J.-L. Jacob and H. Chrestin, Eds.), 345-403. CRC Press Inc, Boca Raton, Florida.

Krishnakumar, R. and J. Jacob (2002) "Effect of panel changing on tapping panel dryness in Hevea brasiliensis. Indian Journal of Natural Rubber Research, 15 (1): 96-99.

Lacote R., Obouayeba S., Clément-Demange A;, Dian K., Gnagne M., and Gohet E. (2004) Panel management in rubber (Hevea brasiliensis), tapping and impact on yield, growth and latex diagnosis. Journal of Rubber Research, 7(13), 199-217.

Serres, E., Clément, A., Prévôt, J. C., Jacob, J. L., Commère, J., Lacrotte, R., and Eschbach, J. M. (1988) Clonal typology of laticiferous producing vessels in Hevea brasiliensis. In CR. Int. Rubb. Res. Dev. Board, Expl. Physiol Amél. Hevea. J.L. Jacob and J.C. Prévôt, ed., IRCA-CIRAD, Montpellier, 231-246.

SAS (1988) SAS/STATUser's guide, version 6.03 SAS Institute, Cary, NC.

Sivakumaran, S., S. W. Pakianathan and Gomez J.B. (1983). "Long-term ethephon stimulation. III. Effect of continuous ethephon stimulation with short-cut panel-changing system." Journal of the Rubber Research Institute of Malaysia, 31(3): 151-174.

Van de Sype, H. (1984) The dry cut syndrome in Hevea brasiliensis, evolution, agronomical and physiological aspects. In C.R. Coll. IRRDB Physiol. Expl. Amél. Hevea. IRCA-CIRAD, ed., Montpellier, 227-249.