H. OMONT

REPORT ON THE MISSION TO THE SOCFINDO ESTATES
IN INDONESIA

16th to 27th October 1991
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IRCA

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This phytopathology mission was carried out under a technical assistance agreement between SOCFINDO and IRCA.

The programme was organized by Messrs. Tampobulon, Head of Agricultural Department, Sitepu, Rubber Agronomist, and Sinuraja, Rubber Protection.

Tours of the estates at Tanjung Maria (18/10/91), Tanah Besih (19/10/91), Aek Pamenkie (21 and 22/10/91), Halimbe (23/10/91) and Lima Puluh (24/10/91) were conducted by the Estate Managers (Messrs. Hagadlin, Yan Paris Sirait, Sahala Sormin, Said Aliun and Idris Daud respectively).

Mr. Hamri Halim, the Group Manager, accompanied us on our visit to the Lima Puluh estate.

A final meeting was held with Messrs. Balot, Principal Director, Ruesh, Estates Advisor, Tampubolon, Sitepu and Sinuraja (26/10/91).

White root disease caused by *Rigidoporus lignosus* is the main problem facing *hevea* plantations in North Sumatra. However, the phytosanitary measures taken over recent years are beginning to pay off and disease incidence is tending to diminish in young plantings.

Following the relatively dry period in July-August, secondary leaf fall caused by *Colletotrichum gloeosporioides* remained less serious this year than in previous years.

However, an epidemic caused by *Oidium heveae* developed on the clones most susceptible to this pathogen.

Clone GT1, which has good resistance to *Oidium* had an optimum foliage density in October 1991, but the foliage of clones PB235 and PB260, which are less resistant to *Oidium*, was much less dense. Clone PR261 was severely affected.

Corynespora cassiicola attacks are spreading on all the estates. This pathogen often develops under the same conditions as *Colletotrichum* and the respective damage caused by each of these fungi is difficult to assess.

Bark necrosis phenomena are continuing to develop, especially in the GT1 and AVROS 2037 plantings over 10 years old.

WHITE ROOT ROT DISEASE

DISEASE DEVELOPMENT

Changes in the number of dead trees

A comparison between the number of dead trees in July 1989, 1990 and 1991 can provide an idea of how the disease is evolving, although not all the losses can be attributed to white root disease alone.

The average increase in the rate of dead trees on all the SOCFINDO estates was 5.7% between July 1989 and July 1990. Between July 1990 and July 1991, the rate was 3.8% (table 1). The number of dead trees therefore increased less between 1990 and 1991 than during the previous year.

It is worth noting that the greatest increase in the number of dead trees between 1990 and 1991 was recorded at Lima Puluh (8.3%). This estate suffered from very serious wind damage in the first half of 1991 during a particularly violent storm. As the average number of dead trees basically corresponds to the sum of the numbers of trees killed by *R. lignosus* and losses caused by wind damage, the proportion of losses due exclusively to white root disease was therefore less than 3.8%.

At Tanjung Maria and Aek Pamenkie, the percentages of dead trees are still rising regularly, even in young plantings (figures 1 and 4). At Tanah Besih and Lima Puluh, the increase in losses is much lower in the young plantings (figures 2 and 3).

The slowdown in the spread of the disease at the latter two estates is probably due to the meticulous and systematic implementation of the recommended control measures. More effective measures need to be taken at Tanjung Maria and Aek Pamenkie to obtain the same results.

Changes in the number of trees killed by *Rigidoporus lignosus* recorded during detection rounds

Fungicide treatment is preceded by detection rounds, to identify the trees requiring treatment. During these detection rounds, the number of trees killed by *R. lignosus* are recorded.

The average numbers of trees killed by *R. lignosus* observed during detection rounds in 1991 amounted to less than 1% in all the plantings at Tanjung Maria (table 2), Tanah Besih (table 3), Lima Puluh (table 4), Aek Pamenkie (table 5) and Halimbe (table 6).

Table 1: Changes in the average number of missing trees on the SOCFINDO estates between July 1989 and July 1991

	TANJUNG MARIA	TANAH BESIH	LIMA PULUH	AEK PAMENKIE
1989	18.5	17.2	18.0	16.2
1990	23.9	24.7	21.6	23.6
1991	25.2	25.0	29.9	28.9

Table 2: Changes in the numbers of trees killed by *R. lignosus*, recorded during detection rounds at Tanjung Maria

Planting dates	ha	détection rounds			
		1988	1989	1990	1991 (*)
1984	94	5.08	5.29	-	-
1985	51	2.78	-	0.32	-
1986	162	1.27	5.51	1.81	0.77
1987	74	-	0.12	1.36	0.78
1988	102	-	-	1.23	0.77
1989	53	-	-	0.31	1.39
1990	53	-	-	-	0.77
Total	589	2.61	4.14	1.25	0.90

(*) up to July

Table 3: Changes in the numbers of trees killed by *R. lignosus*, recorded during detection rounds at Tanah Besih

Planting dates	ha	detection rounds			
		1988	1989	1990	1991 (*)
1983	109	2.18	-	-	-
1984	77	1.46	0.45	-	-
1985	87	2.81	1.04	0.41	-
1986	62	1.27	0.41	0.41	0.16
1987	57	-	0.96	1.86	1.45
1988	45	-	0.40	2.21	0.19
1989	59	-	-	0.54	0.38
1990	53	-	-	-	0.24
Total	555	2.00	0.68	1.00	0.51

(*) up to July

Table 4: Changes in the numbers of trees killed by *R. lignosus*, recorded during detection rounds at Lima puluh

Planting dates	ha	detection rounds			
		1988	1989	1990	1991 (*)
1983	88	2.58			
1984	84	3.52	2.69	-	0.07
1985	100	1.32	6.89	0.37	0.60
1986	128	2.48	4.29	1.27	0.66
1987	61	-	0.14	0.38	0.09
1988	89	-	-	0.78	0.47
1989	36	-	-	1.69	0.17
1990	53	-	-	-	0.24
Total	611	2.53	4.09	3.83	0.85

(*) up to July

Table 5: Changes in the numbers of trees killed by *R. lignosus*, recorded during detection rounds at Aek Pamenkie

Planting dates	ha	detection rounds			
		1988	1989	1990	1991 (*)
1985	162	1.36	1.29	1.37	0.48
1986	230	0.04	0.16	0.42	0.12
1987	303	-	0.11	1.03	0.50
1988	200	-	0.22	1.26	0.42
1989	25	-	-	1.93	0.13
Total	921	0.57	0.35	1.01	0.37

(*) up to July

Table 6: Changes in the numbers of trees killed by *R. lignosus*, recorded during detection rounds at Halimbe

Planting dates	ha	detection rounds			
		1988	1989	1990	1991 (*)
1983	114	2.80	-	-	0.03
1984	390	0.04	0.19	-	0.05
1985	315	0.96	0.07	0.52	0.00
1986	235	0.26	0.48	0.51	0.29
1990	94	-	-	-	0.26
Total	921	0.66	0.23	0.51	0.10

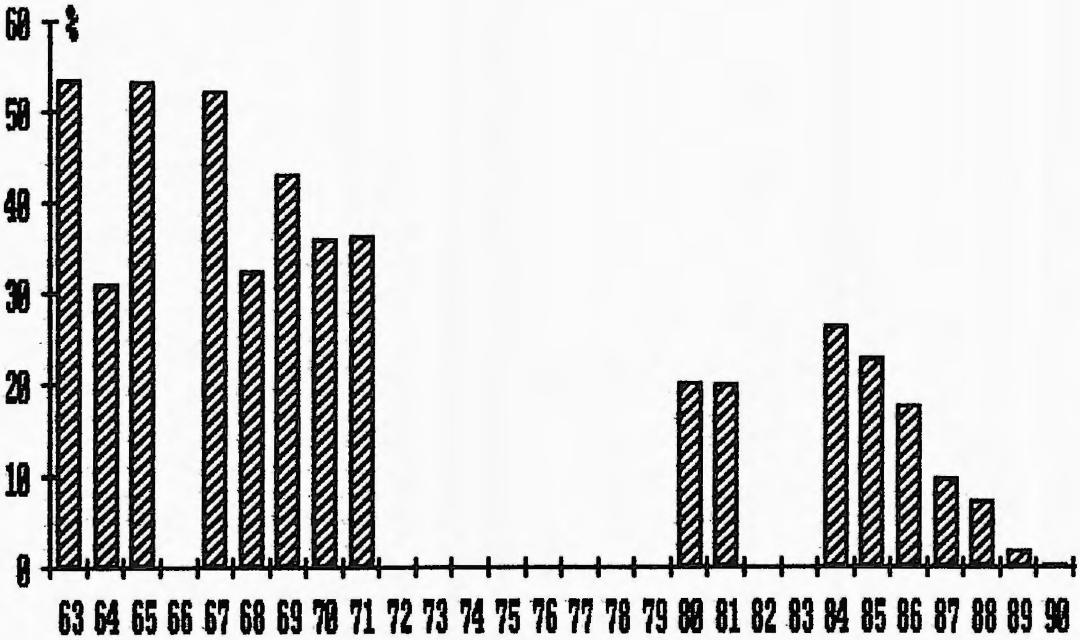
(*) up to July

Table 7: Comparison of the overall results in detection rounds between 1988, 1989, 1990 and 1991, in all SOCFINDO estates

	1988	1989	1990	1991(July)
Tanjung Maria	2.61	4.14	1.25	0.90
Tanah Besih	2.00	0.68	1.00	0.51
Lima Puluh	2.53	4.09	3.83	0.85
Aek Pamenkie	0.57	0.35	1.01	0.37
Halimbe	0.66	0.23	0.51	0.10
Total	1.67	1.90	1.52	0.55

Figure 1: Missing tree rates on the Tanjung Maria estate

1. Up to July 1991



2. Comparison between 1989, 1990 and 1991

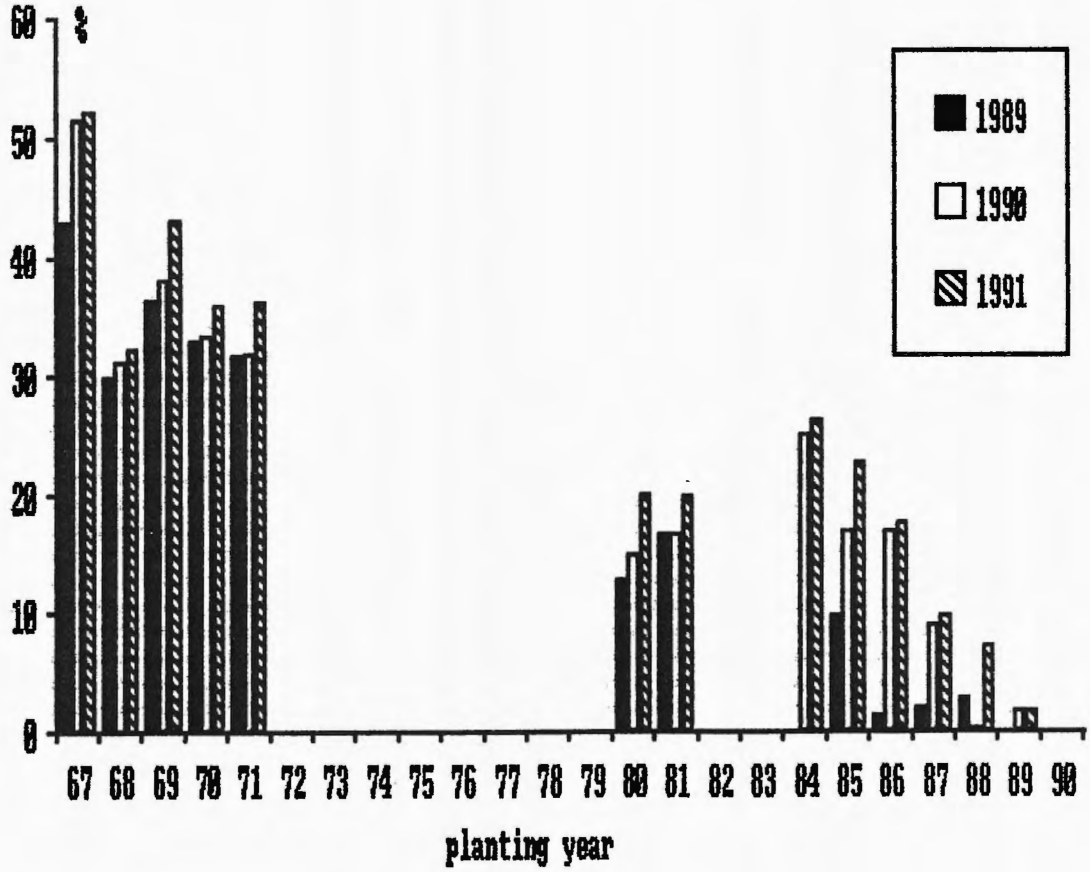
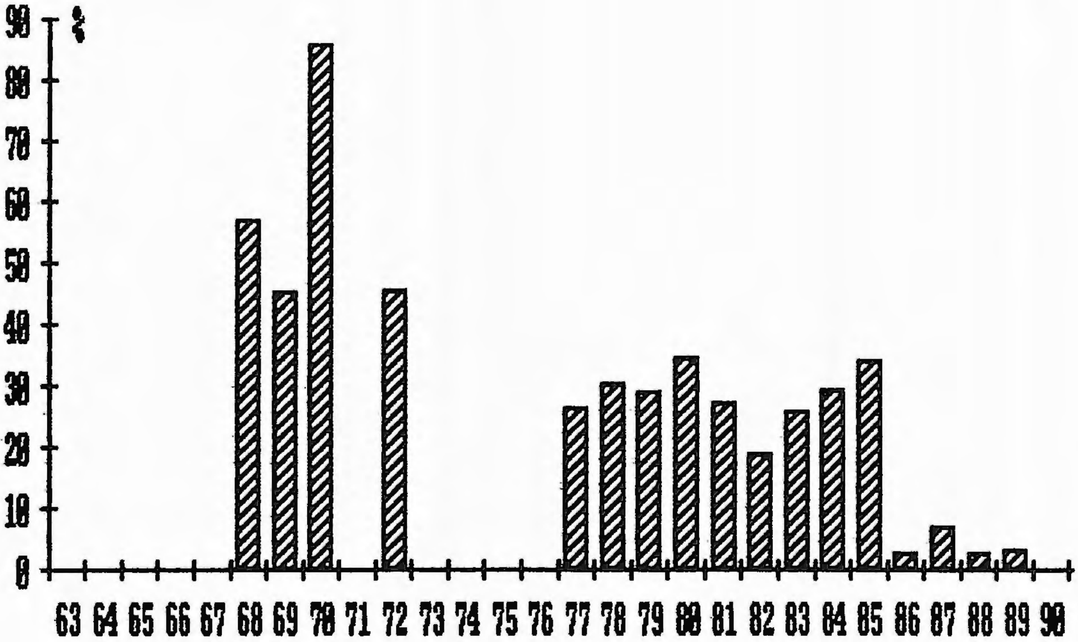


Figure 2: Missing tree rates on the Tanah besih estate

1. Up to July 1991



2. Comparison between 1989, 1990 and 1991

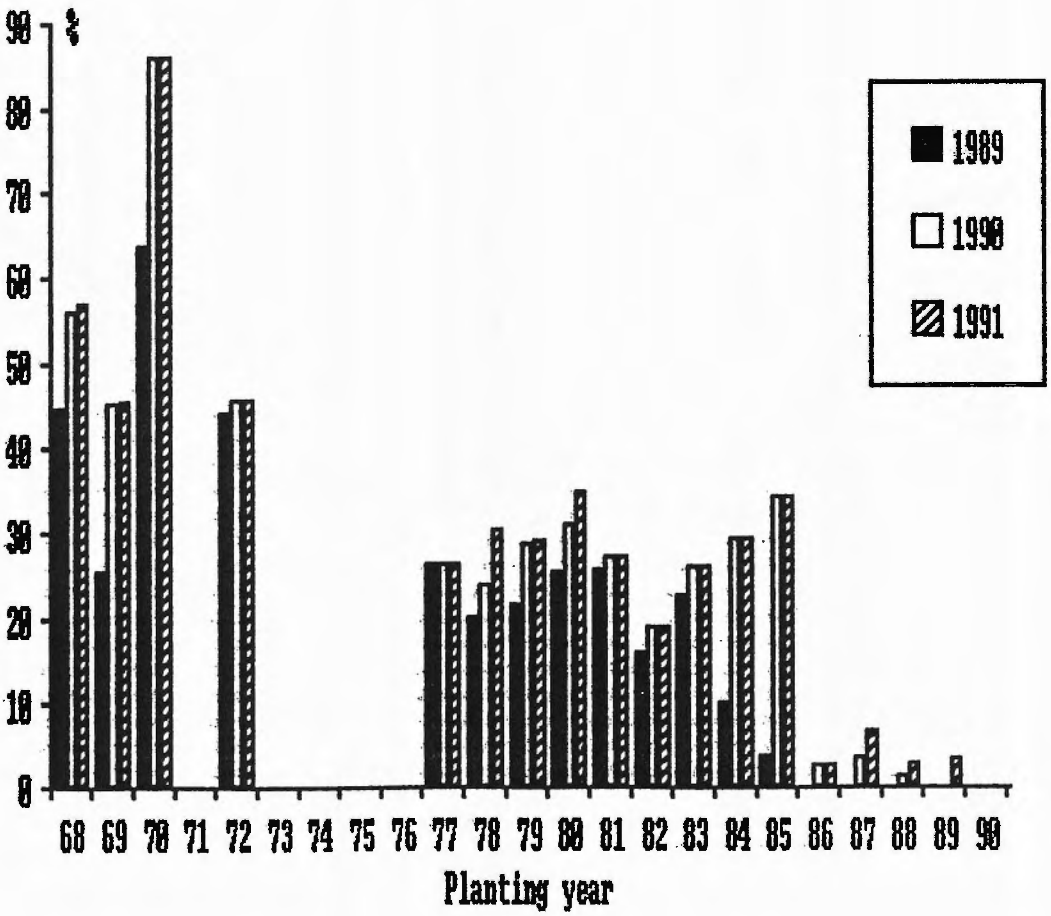
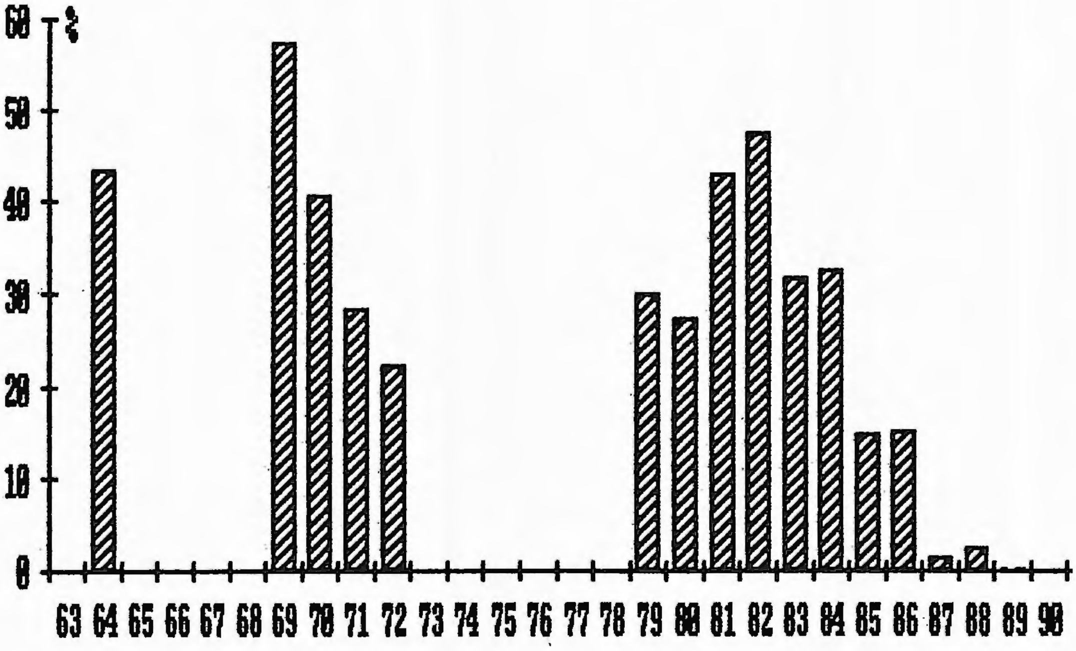


Figure 3: Missing tree rates on the Lima puluh estate

1. Up to July 1991



2. Comparison between 1989, 1990 and 1991

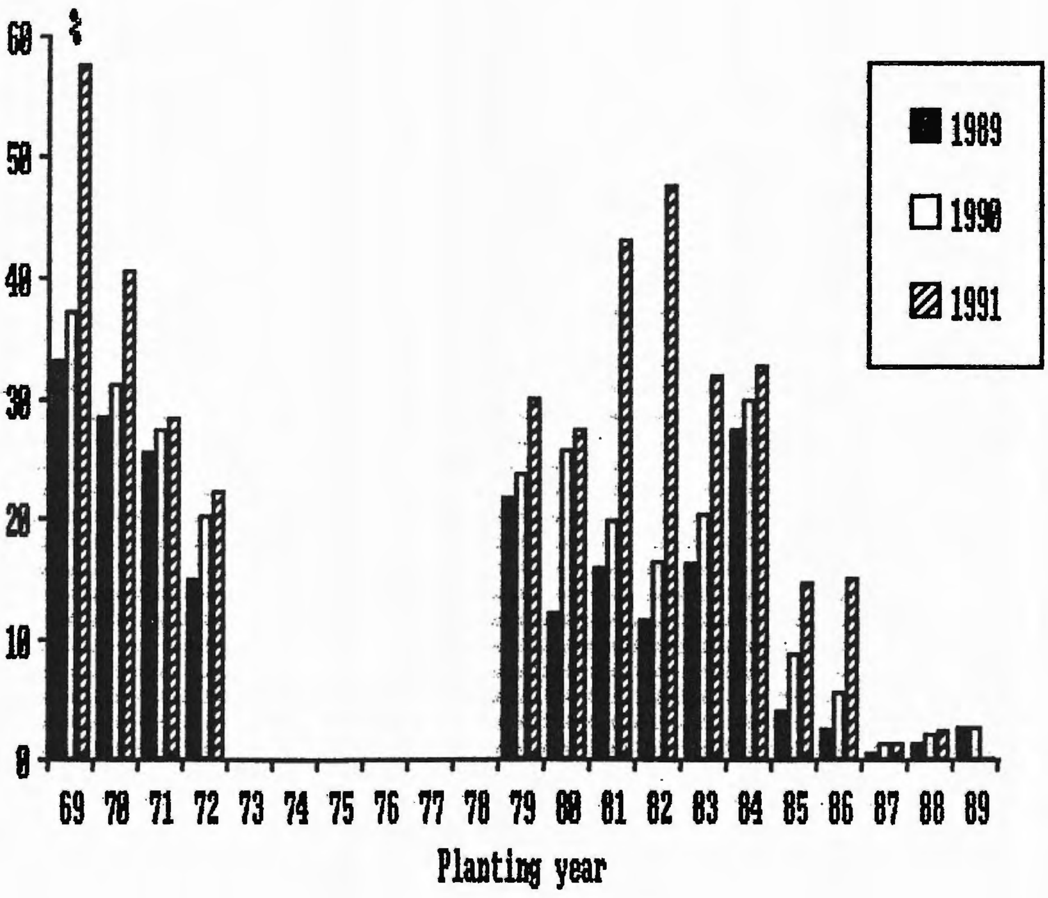
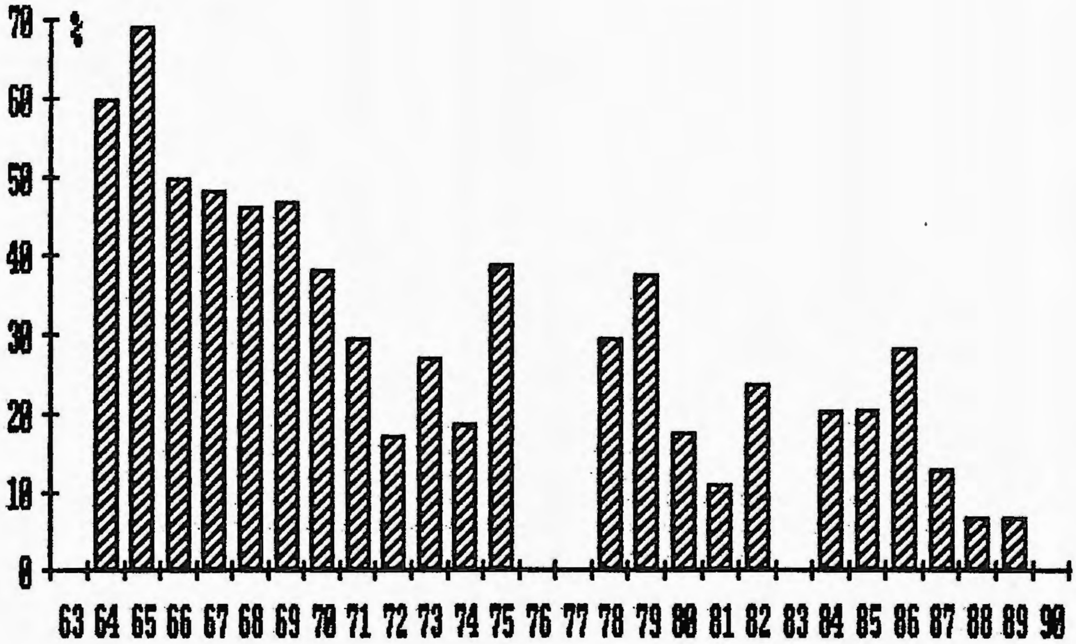


Figure 4: Missing tree rates on the Aek pamenkie estate

1. Up to July 1991



2. Comparison between 1989, 1990 and 1991

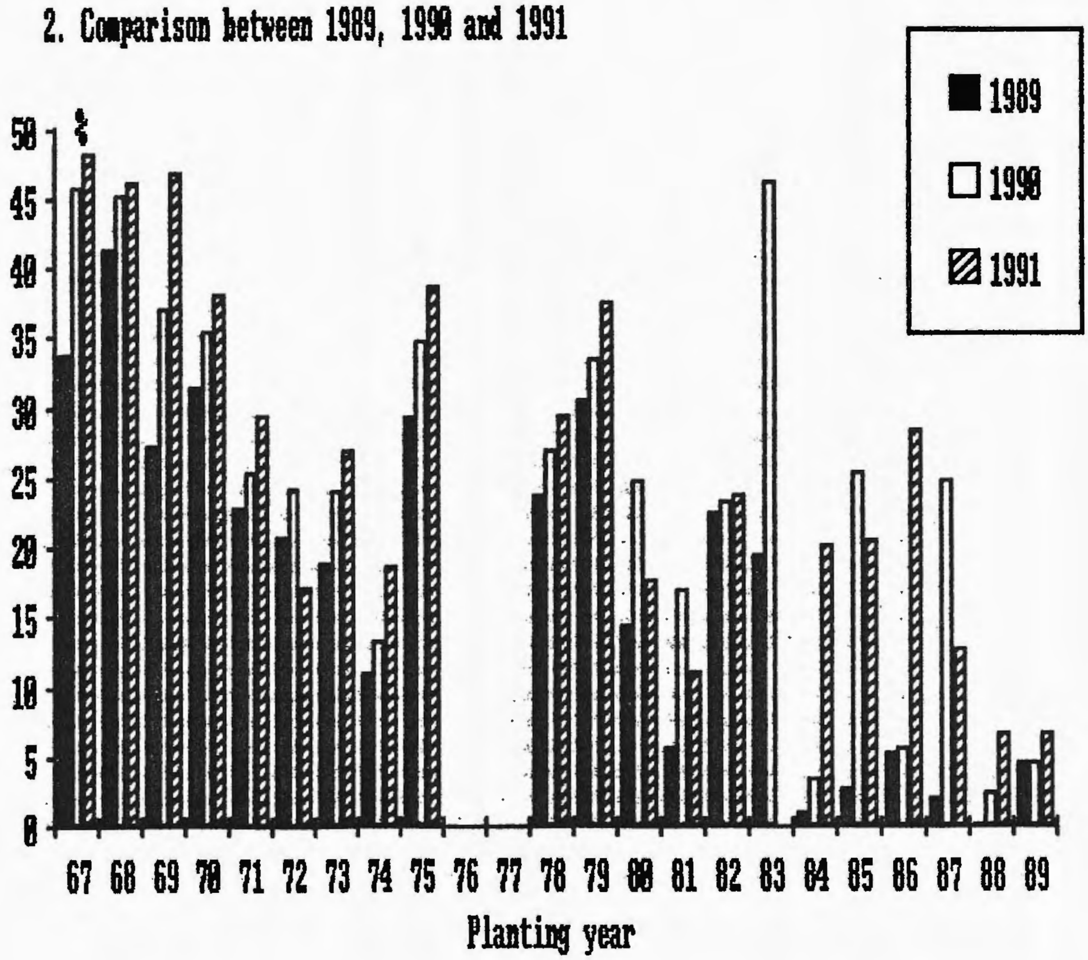
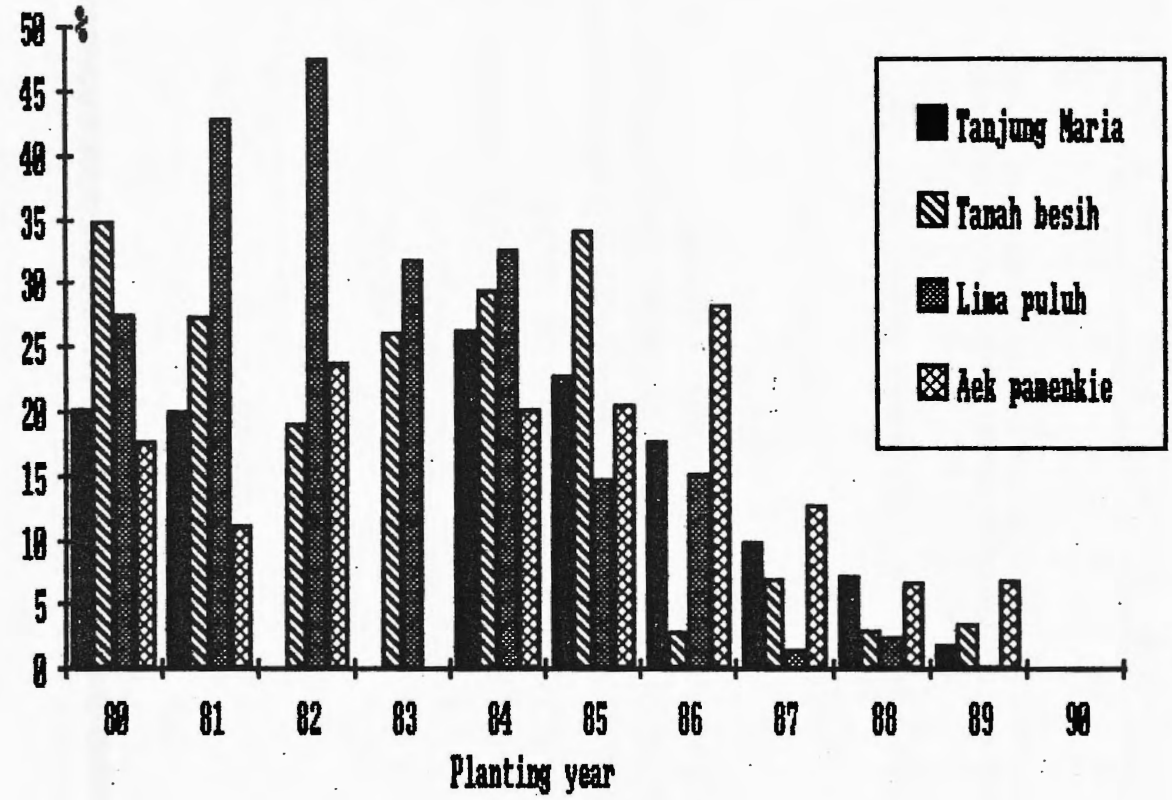


Figure 5: Missing tree rates noted in July 1991 on the SOCFINDO estates in plantings 1980 to 1990



The highest rates were recorded at Tanjung Maria (0.90%) and Lima Puluh (0.85%). However, a comparison with records from previous years clearly shows a marked slowdown in the death rate due to the disease at these two estates also.

The lowest rates were recorded at Aek Pamenkie and Halimbe. These low death rates are somewhat surprising when compared to the evolution diagram for dead trees at Aek Pamenkie. In fact, in the 1986 to 1990 plantings, the dead tree rates are higher at Aek Pamenkie than at all the other estates (figure 5). In these young plots, which are not particularly susceptible to wind damage, losses can only be explained by high *R. lignosus* incidence. The effectiveness of the detection rounds ought to be checked on these estates and it should be ensured that the records are being kept correctly.

Overall results for the detection rounds, for all planting ages combined, indicate a reduction in deaths caused by *R. lignosus* throughout the 5 estates since 1989 (table 7).

FUNGICIDE TRIALS UNDER WAY

Comparative trial between drenching applications and painting with Bayfidan and Alto (TM AP 03)

Tanjung Maria Estate, Block 8, 1987

The rates applied at the beginning of this trial were too low to prevent disease development. This explains the mean results obtained following these treatments, even with drenching (table 8).

However, it clearly seems that the painting method does not provide adequate disease control.

It should be noted in this trial that disease control is equivalent in the plots treated with Bayleton and Alto, though the amount of active ingredient applied was 5 times less in the case of Alto. Cyproconazole (the active ingredient of Alto) is therefore more effective than triadimefon (the active ingredient of Bayleton).

There is no need to continue with this trial in 1992.

Table 8: Comparison between drenching and painting fungicide application methods (MZ AP 03)

Fungicide	Application method	A	B	C	D
Bayleton	Drenching (5g a.i./tree)	86	14	17	2
	Painting (0,5g a.i/tree)	44	24	28	7
	Total	130	38	45	9
Alto	Drenching (1g a.i./tree)	69	16	18	3
	Painting (0,1g a.i/tree)	58	20	29	1
	Total	127	36	47	4

(A: trees becoming healthy; B: neighbours of diseased tree; C: diseased trees; D: dead trees)

Comparative trials of fungicide treatments with Fomac, Bayfidan, Alto and Anvil (TM AP 04)

Tanjung Maria Estate, Block 8, 1987

This trial was set up in December 1990 for 2 years. During the visit only the data recorded just before the second application in June 1991 - only six months after the start of the experiment - were available. The results obtained can only be considered preliminary.

The tendency revealed is firstly the good overall effectiveness of the treatments (table 9). In fact the death rate never reaches 2%, whereas the trees treated are either diseased trees or their direct neighbours.

Tree deaths were only recorded in the batches treated with Fomac-II and Anvil. However, these results only involve a very small number of dead trees and cannot be considered significant.

Any analysis of the number of diseased trees should be undertaken with care, since scraping of diseased parts, which is only carried out with Fomac-II treatments, introduces bias which is difficult to weight. Furthermore, one treatment may be effective as regards tree deaths, without preventing rhyzomorph growth. Nevertheless, it clearly seems that Alto has a strong inhibitive effect on rhyzomorph growth.

An initial analysis of this trial seems to indicate that Alto is the best fungicide for controlling the disease, for equivalent quantities of active ingredient. Nevertheless, all the other fungicides are effective. Anvil seems to be less active than Alto or Bayfidan.

This trial should be continued in 1992.

Comparative trial between preventive treatments on all the trees and treatments only applied to trees found to be diseased, or their immediate neighbours (TM AP 05)

Tanjung Maria Estate, Block 22, 1990

This trial was set up in February 1991 for 2 years. Interpretation of results based exclusively on the July 1991 records can only be considered as preliminary.

For each treatment, the mean death rates observed in July 1991 in 4 replicates were 0.6% (table 10). For each type of treatment, this corresponds to an average increase of 0.3 to 0.4% for the 6 months since the trial was set up. This low increase confirms the effectiveness of each of the treatments.

As regards the death rates, no significant difference appears between the treatments.

Table 9: Fungicide treatments effectiveness six months after the first application

Fungicides	Tree classes (%)		
	Healthy	Diseased	Dead
Fomac II (*)	95.97	3.23	0.80
Bayfidan G (1,0 g a.i./tree)	89.62	10.38	0
Bayfidan G (2,5 g a.i./tree)	96.53	3.47	0
Alto 100 SL (1,0 g a.i./tree)	97.23	2.77	0
Alto 100 SL (2,5 g a.i./tree)	100.00	0	0
Anvil 50 SC (1,0 g a.i./tree)	94.49	4.59	0.92
Anvil 50 SC (2,5 g a.i./tree)	93.81	4.42	1.77

(*): Coated on to uncovered root system.
Bayfidan G is in granule form, applied on the soil around the collar. Alto and Anvil are applied in liquid form, diluted in water around the collar (2 lit/tree)

Table 10: Effectiveness comparison between preventive treatements on all trees and curative treatments on detected diseased trees and their neighbours

Fungicide	treatment	Initially (Feb 91)		July 1991		Difference	
		sick	dead	sick	dead	sick	dead
Fomac	selective	2.9	0.2	1.2	0,5	-1.4	0.3
	all trees	2.3	0.2	1.2	0.6	-1.1	0.4
Bayfidan	selective	2.7	0.3	2.2	0.6	-0.6	0.3
	all trees	2.6	0.2	2.0	0.6	-0.6	0.4

Results are expressed ias a pourcentage of total initial trees

The reduction in the number of trees found to be diseased was greater with Fomac-II than with Bayfidan. However, as in the case of trial TM AP 05, this result is difficult to interpret, due to the differences in treatment application methods, especially necrotic bark scraping when treating with Fomac-II.

To date, selective treatment on diseased trees and their neighbours reveals effectiveness equivalent to the treatments applied to all the trees.

This trial should be continued in 1991. In order to take the increase in tree diameter into account, Bayfidan should be applied in 1992 at a rate of 1.25 g of a.i./tree.

RECOMMENDATIONS

An analysis of the number of dead trees revealed lower disease incidence at the beginning of 1991.

The most probable hypothesis for explaining the slowdown in the spread of the disease in 1990 and 1991 is better implementation of phytosanitary measures (cropping and chemical) over recent years.

Nevertheless, the lower incidence in 1991 may also be partly due to climatic conditions less suited to *R. lignosus* development. Subsequent campaigns will determine whether or not this hypothesis is correct.

Soil preparation before replanting

Ripping and successive criss-cross ploughing remove from the soil most of the woody substrates likely to become primary infection sites before planting.

Nevertheless, particular care should still be taken in the final manual removal stages - the success of the operation depends on this. Shoddy manual removal leads to focus dispersal and multiplication, which may cause a substantial increase in the soil's infection potential.

Disease control after planting

Fungicide treatments

The main fungicide used in 1991 to control white root rot disease was Fomac-II. This fungicide is no longer available on the market since authorization has been withdrawn for production of its active ingredient, P.C.N.B.

Ingro-Pasta, which is also made with P.C.N.B. may soon be unavailable too.

Hence, it has now become essential to use new fungicides. This changeover should lead to greater effectiveness, as the trials conducted over the last two years at SOCFINDO have revealed the greater effectiveness of the new methods.

The recommended treatment procedure is indicated in table 11.

The recommended rates are high enough to guarantee the maximum effectiveness of fungicide treatments. Nevertheless, if the aim is to obtain greater effectiveness than with conventional treatments with Fomac-II, the trial results obtained at SOCFINDO show that treatments with Alto at 1 g of a.i./tree and Bayfidan at 1.5 g of a.i./tree are already very effective.

Crop Upkeep

The effectiveness of chemical control largely depends on implementation of other phytosanitary measures capable of reducing infection potential. It is therefore necessary to ensure regular removal of all potential infection sources from plantings, and especially to eradicate dead or incurable trees. These measures should be implemented in young plantings and in older plantings. Indeed, the level of infection potential in the soil when replanting depends on adequate crop upkeep throughout the plantation's working life.

SETTING UP NEW FUNGICIDE TRIALS

TM OP 01: Small-scale comparative trial of different Alto, Bayfidan and Bayleton rates

Location: Tanjung Maria

This trial, due to be conducted over a period of six months, should rapidly provide information for adjustment of application rates for each of the three fungicides.

The rates compared will be 1, 2, 3, 4 and 5 g of a.i./tree, in a randomized experimental design with 5 replicates per treatment.

Table 11: Schedule for chemical disease control recommended on SOCFINDO estates

a) Methods and frequency of application

Year 1	Preventive application on all trees 1 application
Years 2 and 3	selective application 3 detection rounds, 3 applications
Years 4 and 5	selective application 2 detection rounds, 2 applications
Years 6 to 8	selective application 1 detection round, 1 application

Selective application: on diseased trees and their neighbours

b) Fungicides and application rates

Fungicide	Preventive application (8-12 months)	Curative application (year 2 to year 8)
Alto 100SL	0.75 g a.i./tree (7.5 cc c.p./tree)	1.5 g a.i./tree (1.5 cc c.p./tree)
Bayfidan 3G	1.5 g a.i./tree (50 g c.p./tree)	3 g a.i./tree (100 g c.p./tree)
Bayleton 25EC	2.5 g a.i./tree (10 cc c.p/tree)	5 g a.i./tree (20 cc c.p/tree)

a.i.: active ingredient; c.p.: commercial product

Photo 1: Small scale fungicide experiment setting up
(Ivory Coast, 1990)

The experimental procedure will be as follows:

Trial preparation

1) Prepare a nursery so that 2,500 6-month-old seedlings will be available for setting up the trial.

2) During eradication operations, recover and group together a hundred or so tap roots from trees killed by *R. lignosus* near the experiment site. They should be around 40 cm in diameter and about 60 cm long.

3) Prepare a flat area 50 m x 40 m, as for setting up a nursery.

Setting up the trial (preferably just before the rainy season)

1) Set out the dead *R. lignosus* infected tap roots in a 3 m x 3 m square design, pushed 40 cm into the soil. 8 rows of 10 tap roots.

2) Plant 25 seedlings around each of the tap roots (photo 1).

3) Apply a fungicide treatment around each tap root, as if it were a diseased tree in a planting. Treatment distribution on the tap roots should be drawn at random, so that each treatment type (i.e. one fungicide and a single rate) is applied to 5 tap roots. Five untreated tap roots will be left and used as controls.

Records

Each month for 6 months, the number of dead seedlings will be recorded around each tap root. After the final recording operation, all the seedlings will be pulled up and the number of seedlings with diseased roots will be recorded, as will the number of seedlings with healthy roots.

A comparison of death percentages and the percentages of seedlings with diseased roots will make it possible to categorize fungicides according to their effectiveness and in accordance with each of the rates tested.

SP AP 01: Check of the effectiveness of the preventive treatments applied to all young trees

This trial sets out to compare the effectiveness of preventive treatments applied to all young trees during the first cropping year. Three fungicides will be tested, taking Fomac-II as a reference. If the quantities of Fomac-II are insufficient, the reference treatment will be treated with Ingro-Pasta.

Setting up

Location: Tanjung Maria, Tanah Besih and Lima Puluh

Planting year: 1991

On each of the three estates, four 1991 planting blocks will be selected and treated as follows:

Block 1	drenching with Alto	(0.75 g. a.i./tree)
Block 2	drenching with Bayfidan	(1.50 g. a.i./tree)
Block 3	drenching with Bayleton	(2.50 g. a.i./tree)
Block 4	painting with Fomac-II	

Records

The first data will be recorded just before the first treatments.

The second set of data will be recorded 4 months later

Subsequent operations will be decided according to the results indicated in the first two sets of records.

SO AP 02: Check of the effectiveness of treatments applied on diseased trees and their immediate neighbours after detection rounds

This trial sets out to compare the effectiveness of commercial type treatments in accordance with the fungicides and application rates used. This experiment complements trial TM OP 01 already described. Three fungicides will be tested, taking Fomac-II as a reference. If the quantities of Fomac-II are insufficient, the reference treatments will be treated with Ingro-Pasta.

Setting up

Location: Tanjung Maria, Tanah Besih and Lima Puluh

Planting year: 1989

At each of the three estates, ten 1989 planting blocks will be selected and treated as follows:

Block 1	drenching with Alto	(0.75 g. a.i./tree)
Block 2	drenching with Alto	(1.00 g. a.i./tree)
Block 3	drenching with Alto	(1.50 g. a.i./tree)
Block 4	drenching with Bayfidan	(1.25 g. a.i./tree)
Block 5	drenching with Bayfidan	(2.00 g. a.i./tree)
Block 6	drenching with Bayfidan	(3.00 g. a.i./tree)
Block 7	drenching with Bayleton	(1.25 g. a.i./tree)
Block 8	drenching with Bayleton	(2.50 g. a.i./tree)
Block 9	drenching with Bayleton	(5.00 g. a.i./tree)
Block 10	painting with Fomac-II	

Records

The first data will be recorded just before each treatment.

An initial rundown of results will be drawn up after 2 years.

LEAF DISEASES

SOCFINDO has two clone comparative trials (26 clones, blocks of 80 trees, 4 replicates), one at Aek Pamenkie, the other at Lima Puluh, set up since 1985.

These two trials are very useful for studying the development in leaf diseases in North Sumatra.

Marking is based on the changes in leaf densities, the existence or absence of different diseases on leaves, mortality, percentage of trees tapped and, finally, latex production.

An analysis of mortality records already existing in 1990 showed that there was no significant clone effect. The death rates were primarily linked to root rot diseases, which were randomly distributed in both experiments.

Monitoring of the changes in leaf densities in the multi-clonal trials at Aek Pamenkie and Lima Puluh.

Monitoring of the changes in leaf density in the multi-clonal trial at Aek Pamenkie provides information to explain the development of leaf diseases in this region in 1991.

The natural defoliation period for clone GT1 took place in February-March (figure 6). The beginnings of an increase in leaf density recorded in April-March corresponds to the first stage in natural refoliation. At the end of April/beginning of May, heavy rainfall led to a *C. gloeosporioides* epidemic on newly formed young leaves, which are especially susceptible to this parasite (photo 2). The drop in leaf density observed at the end of May/beginning of June was a direct result of this.

Usually, these irregular defoliation/refoliation cycles last several months on susceptible clones. The rainfall in June, July and August remained untypically low in 1991. This relative drought halted the epidemic process of *C. gloeosporioides*.

Thus, in 1989 and 1990, clone GT1, which is very susceptible to *C. gloeosporioides*, appeared the most often with reduced leaf densities. In the absence of a prolonged *C. gloeosporioides* epidemic in 1991, and by virtue of its very good resistance to *Oidium*, clone GT1 had a very dense canopy by August 1991.

However, the rainfall deficit in June, July and August was very favourable to the development of another leaf parasite which is usually of little importance when rainfall is intense - *O. heveae*, which reached epidemic proportions at an unusual intensity in North Sumatra (photos 3 and 4).

Photo 2:
Colletotrichum gloeosporioides
attack on young leaves

Photo 3:
Oidium heveae
white mycelium spots

Photo 4:
Oidium heveae
attack symptoms on leaves

Figure 6: Evolution of leaf density for GT1 in the Aek Pamenkie multi-clonal trial compared with rainfall

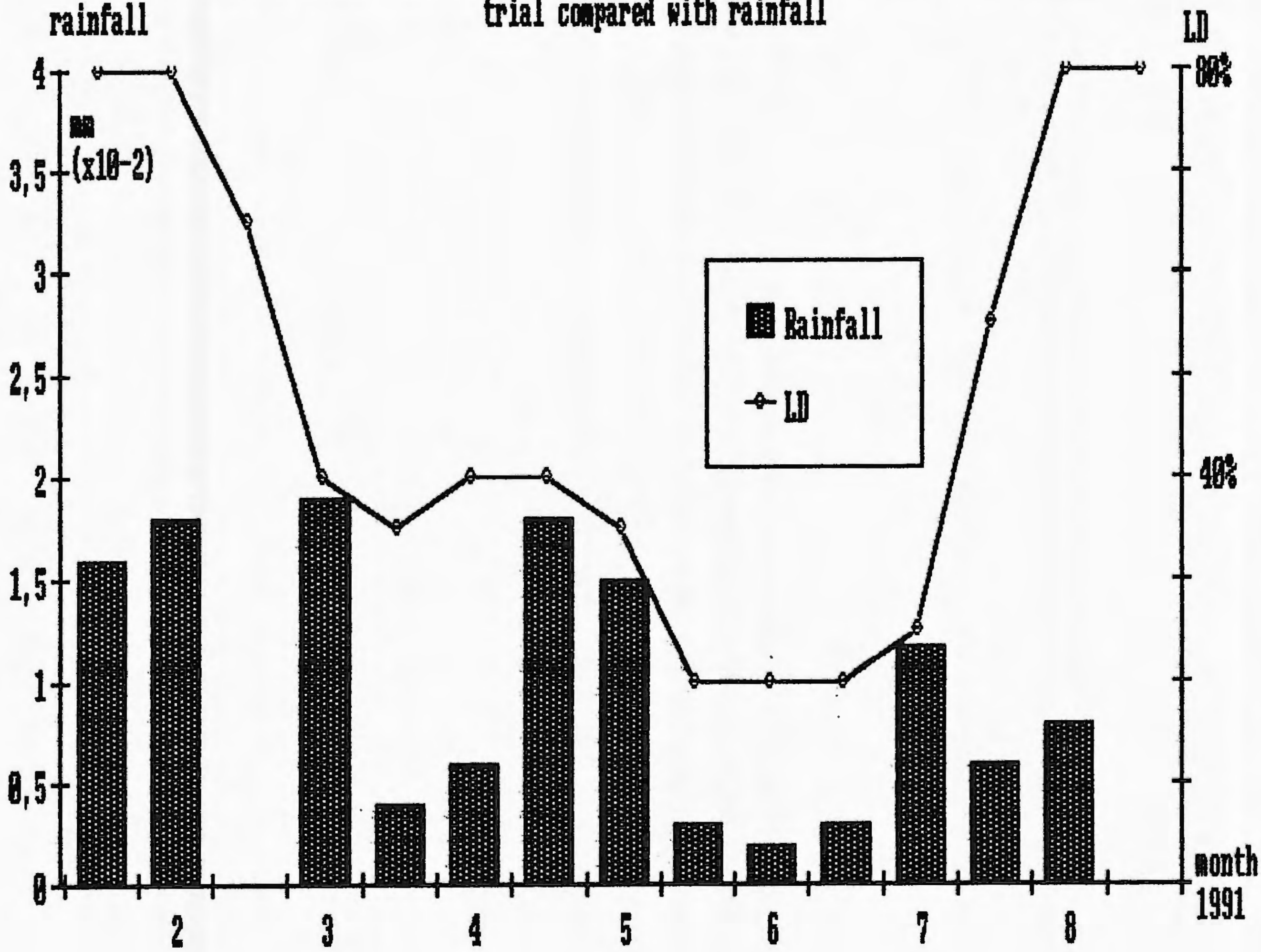
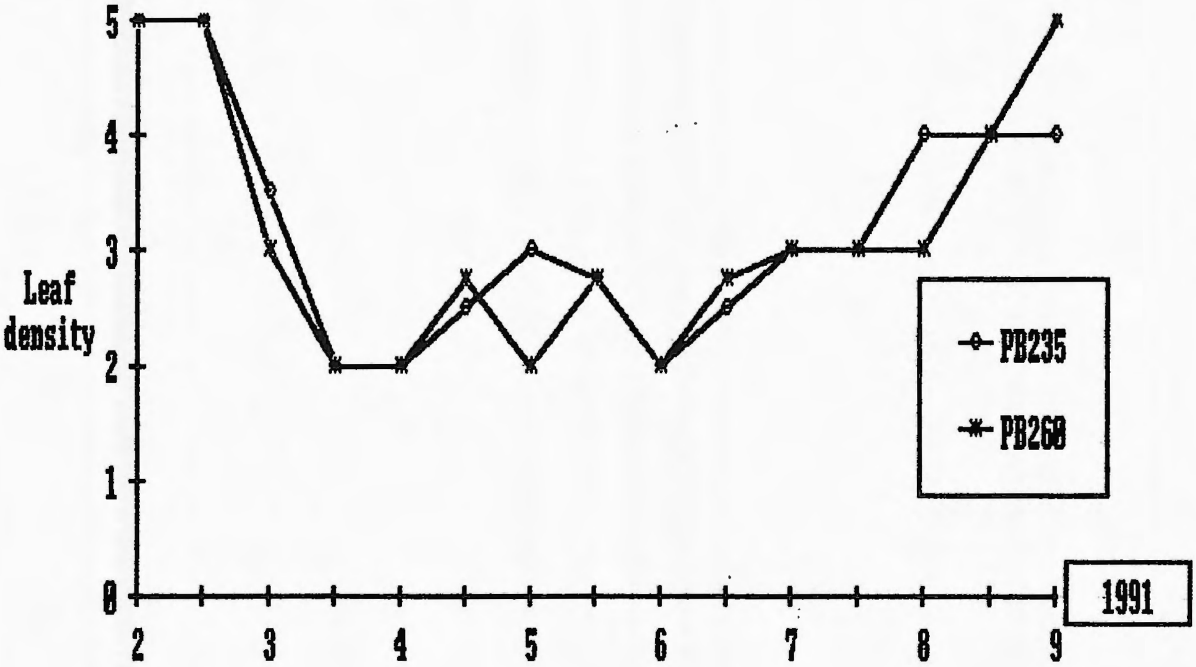


Figure 7: Evolution of leaf density from February to September in the multi-clonal field at Aek Pamenkie

A. clones PB235 and PB260



B. clones GT1 and RRIC100

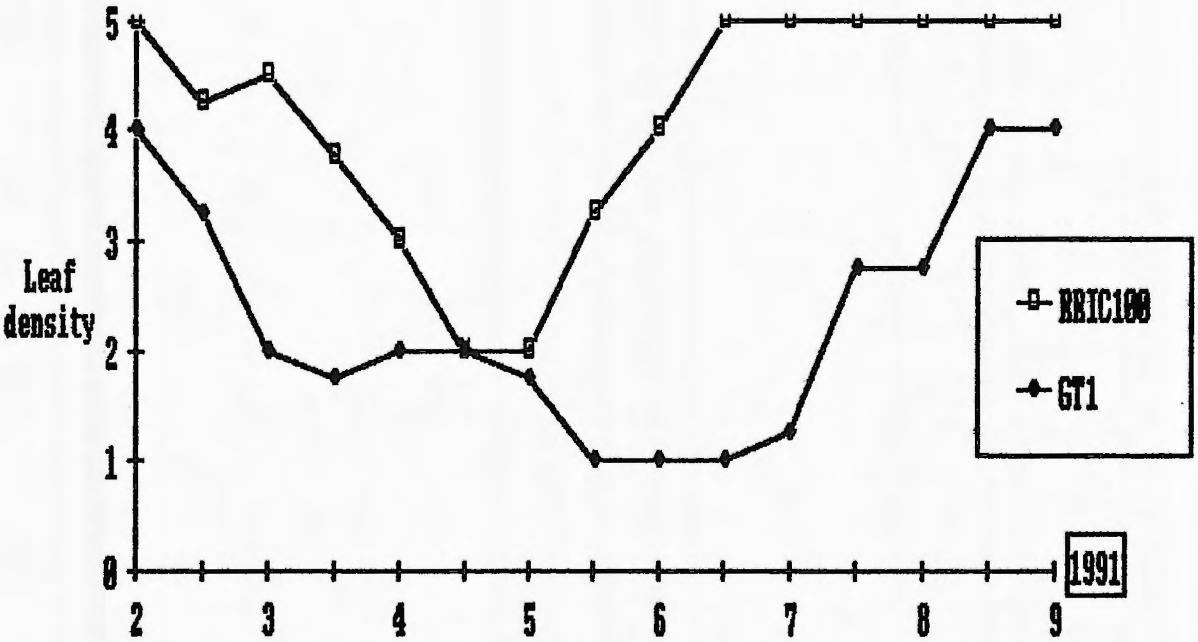
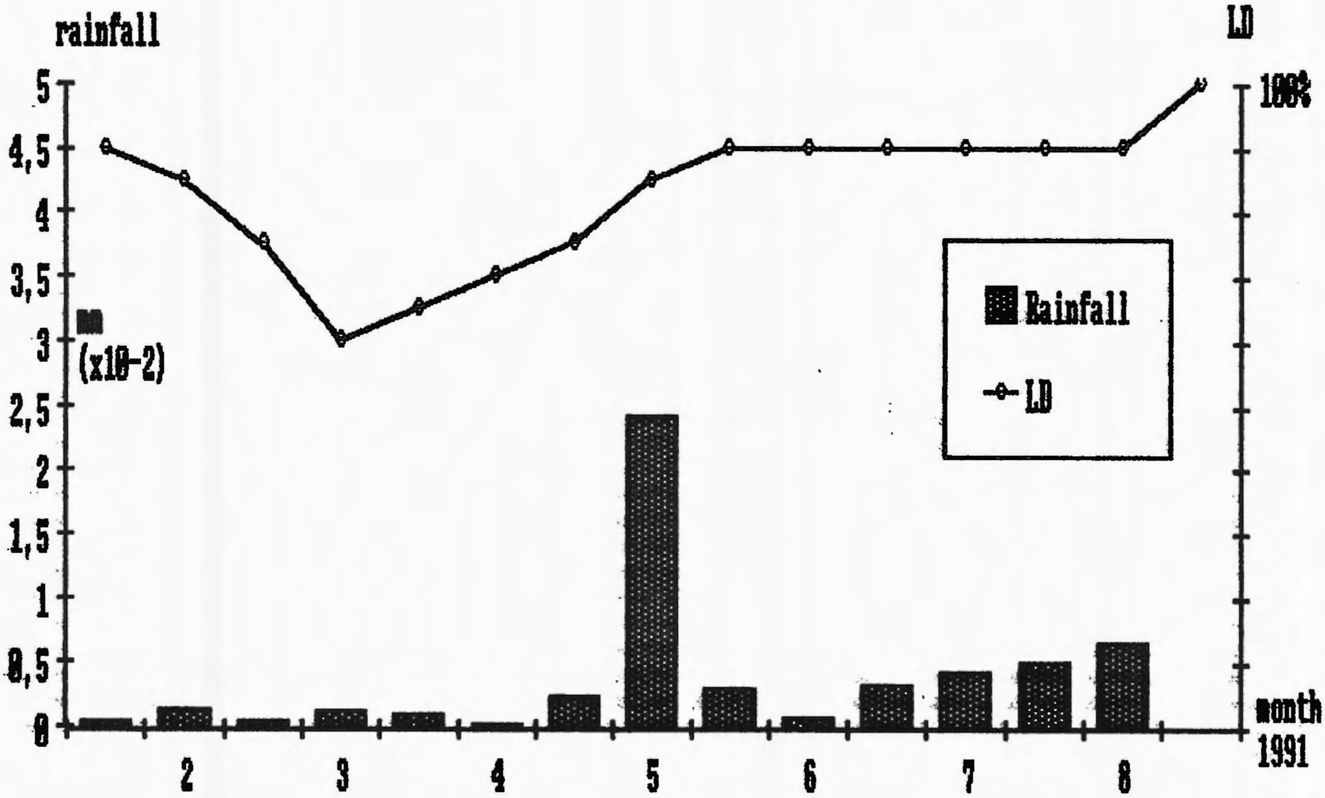


Figure 8: Evolution of leaf density for GT1 in the Lima Puluh multi-clonal trial compared with rainfall



Clones PB235 and PB260, which have high resistance to *C. gloeosporioides*, but low resistance to *Oidium*, had markedly less dense foliage than in previous years. The changes in foliage density recorded in the multi-clonal plot show that the refoliation period was extended by a succession of young leaf falls up to September (figure 7a).

Clone RRIC100 performed excellently as regards both parasites. The *C. gloeosporioides* epidemic in May-June and the *Oidium* epidemic in July-August did not seem to have any particular effect on foliage density, which had returned to optimum by mid-June (figure 7b).

At Lima Puluh, rainfall was once again much lower than at Aek Pamenkie (figure 8). Apart from high rainfall in the second fortnight in May, there was very little rain up to mid-July. The effect of *C. gloeosporioides* on foliage density was very slight, even on the most susceptible clones such as GT1 (figure 8). Likewise, *Oidium* attacks remained very moderate overall.

It should be noted that attacks due to *Corynespora cassiicola* are spreading on both estates. This pathogen develops under conditions similar to those which are also optimum for *C. gloeosporioides*. The variation in symptomatology depending on the clone makes it difficult to separate attacks by these parasites under natural conditions. Given the somewhat unsuitable climatic conditions this year, the incidence of this parasite was probably not very high in 1991. Nevertheless, its ubiquity throughout the estates is worrying. In fact, it is difficult to foresee at the moment what risks will be run if a particularly favourable year for an epidemic outbreak should occur.

In this respect, the disease outbreak that occurred in South Cameroon in 1989 should be remembered. As on the SOCFINDO estates, the serious damage caused by *C. gloeosporioides* in South Cameroon led to clone GT1 being abandoned as it was too susceptible, to be replaced by PB235 and PB260, which have good genetic resistance to this parasite. Since 1989, these plantings have suffered serious *Corynespora cassiicola* attacks, which had been unknown on *hevea* in that region until then.

The extent of the epidemic is such that *Corynespora cassiicola* has now become the major phytosanitary problem on *hevea* in that part of the world.

In this context, detailed and continuous analysis of the two multi-clonal trials at Aek Pamenkie and Lima Puluh is essential for studying the development of these diseases, determine their potential and actual effects on production, forecast epidemic risks and assess possible control methods.

Figure 9: Analysis of the percentages of trees ready for opening in 1991, depending on the clones, in the Aek Pamenkie multi-clonal trial

A. Analysis of variance

VARIANCES	S.C.E.	D.F.	F TEST	Prob.	C.V.
Total	49247	103			
Clones	32119	25	7.47	0.0000	
Blocks	4224	3	8.18	0.0001	
Résidual	12903	75			25,7%

B. Clones classification (NEWMAN-KEULS test)

	CLONE	Mean % of openable trees
1	PB235	86.50
2	RRIC110	70.75
3	RRIC100	70.25
4	PB260	69,25
5	BPM107	67.25
6	RRIC102	66.25
7	RRIC101	64.50
8	BPM1	63.00
9	IAN873	59.00
10	IAN717	58.50
11	TM8	57.50
12	PR309	56.00
13	PR261	55.25
14	IAN710	55.00
15	GT1	54.75
16	RRIM717	48.50
17	TM9	47.50
18	RRIM703	46.50
19	BPM24	44.00
20	TM6	35.50
21	PR300	31.00
22	PR303	27.75
23	RRIM712	27.25
24	PR255	26.50
25	TM7	24.50
26	TM5	12.50

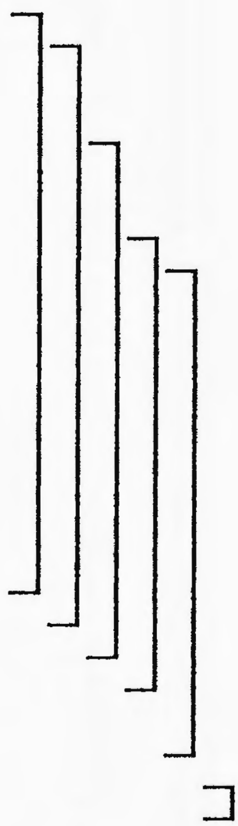
Figure 10: Analysis of the percentages of trees ready for opening in 1991, depending on the clones, in the Lima Puluh multi clonal trial

A. Analysis of variance

VARIANCES	S.C.E.	D.F.	F TEST	Prob.	C.V.
Total	32925	103			
Clones	25203	25	11,43	0,0000	
Blocks	1108	3	4,19	0,0086	
Residual	6613	75			11,8%

B. Clones classification (NEWMAN-KEULS test)

	CLONE	Mean % of openable trees
1	RRIC100	95.44
2	RRIC110	95.25
3	PB260	93.14
4	PB235	93.11
5	BPM107	92.97
6	RRIM703	91.85
7	TM8	91.73
8	RRIC101	91.62
9	TM6	91.19
10	RRIC102	89.42
11	PR255	88.92
12	RRIM717	88.36
13	BPM1	87.80
14	TM9	85.88
15	PR303	84.56
16	PR261	77.75
17	GT1	74.19
18	IAN873	74.14
19	RRIM712	74.05
20	IAN717	70.84
21	BPM24	67.29
22	IAN710	64.45
23	PR300	60.88
24	PR309	59.90
25	TM7	44.94
26	TM5	37.15



Analysis of records of the number of trees opened in the multi-clonal trials

An analysis of the data available relative to the percentages of trees ready for opening (diameter > 50 cm) at Aek Pamenkie is shown in figure 9.

The general average number of trees opened throughout the estate, all clones combined, is 51%. There are high variations depending on the clones: the average percentage of opened trees is 86.5% for PB235 and only 12.5% for TM5.

Classification of clones led to identification of an initial group of 16 clones, between PB235 (86.5%) and RRIM717 (48.5%) for which the numbers of trees opened are not significantly different.

An analysis of the data available relative to the percentages of trees ready for opening at Lima Puluh is shown in figure 10.

The general average number of trees opened throughout the estate, all clones combined, is 79.5%. This rate, which is clearly higher than at Aek Pamenkie reflects better general clone growth. Clone TM5 is still classed last, but the average number of trees opened for this clone increased from 12.5% to 37.17%.

Classification of clones led to identification of an initial group of 19 clones, between RRIC100 (95.44%) and RRIM712 (74.05%) for which the numbers of trees opened are not significantly different.

The five clones with best growth were the same on both estates: RRIC100, RRIC110, PB235, PB260 and BPM107.

Eight other clones are also common to the first two groups: TM8, RRIC101, RRIC102, RRIM717, BPM1, PR261, GT1 and IAN873.

Clones IAN717, PR309 and IAN710 are included in the first group at Aek Pamenkie and excluded from the same group at Lima Puluh. Reciprocally, TM6, PR255, TM9, PR303 and RRIM712 are included in the first group at Lima Puluh and excluded from the same group at Aek Pamenkie.

The higher leaf disease incidences at Aek Pamenkie are probably one of the factors causing slower *hevea* growth on this estate. It should be noted in particular that in 1991, the five clones in the first group at Lima Puluh and absent from the first group at Aek Pamenkie underwent more severe defoliation on the latter estate than the five clones with the best growth (table 12).

Analysis of the production records for the multi-clone trials

The Aek Pamenkie multi-clonal trial has just been opened. The number of production records is still too low for an effective analysis to be made.

Table 12: Opened tree rates and leaf density in June and July 1991 at Aek Pamenkie

clones	Opened tree rates	Leaf density (/RRIC100)	Opened tree rate classes
RRIC100	70.25	100	in Group 1 at Aek Pamenkie and Lima puluh
RRIC110	70.75	44	
PB235	86.50	53	
PB260	69.25	54	
BPM107	67.25	40	
TM6	35.50	28	in Group 1 at Lima Puluh only
PR255	26.50	32	
TM9	47.50	30	
PR303	27.75	30	
RRIM712	27.25	32	

Figure 11: Analysis of the start of production (during the first 9 months) per block depending on the clones, based on the mean weights of the latex collected and dried in the open air for 21 days (S2/D4; stimulation with ethephon at a rate of 70mg of a.i./tree in june) in the Lima Puluh multi-clonal plot

A. Analysis of variance

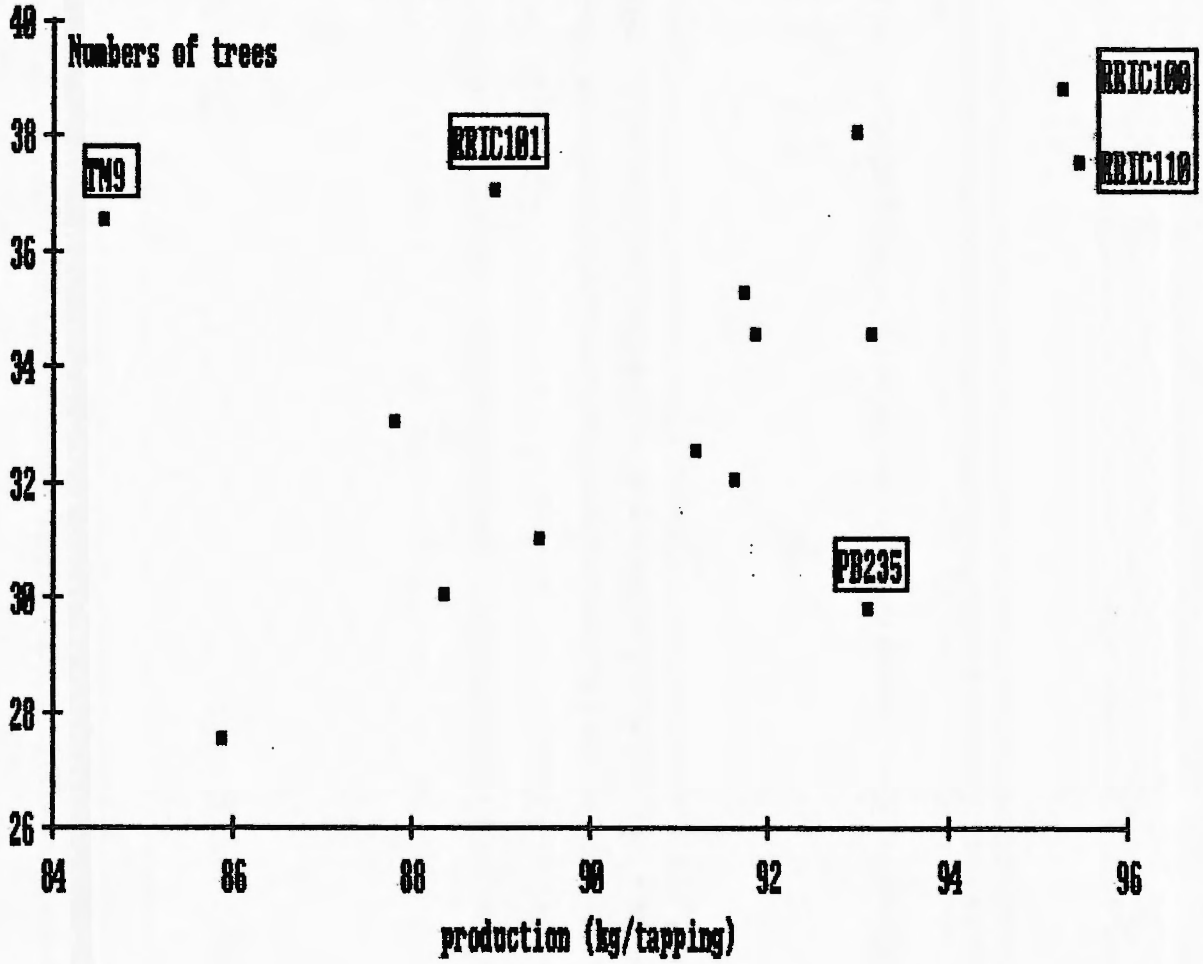
VARIANCES	S.C.E.	D.F.	F TEST	Prob.	C.V.
Total	6.35	59			
Clones	2.90	14	2.66	0,0074	
Blocks	0.18	3	0.76	0,5274	
Residual	3.28	42			25.4%

B. Clones classification (NEWMAN-KEULS test)

	CLONE	Mean % of openable trees (*)	Mean production/ tapping/block (kg)
1	RRIC110	37.50	95.44
2	RRIC100	38.75	95.25
3	RRIM717	34.50	93.14
4	PB235	29.75	93.11
5	BPM107	38.00	92.97
6	BPM1	34.50	91.85
7	PB260	35.25	91.73
8	PR255	32.00	91.62
9	RRIC102	32.50	91.19
10	RRIM703	31.00	89.42
11	RRIC101	37.00	88.92
12	TM6	30.00	88.36
13	PR303	33.00	87.80
14	TM8	27.50	85.88
15	TM9	36.50	84.56

(*) without border trees

Figure 12: Mean block production depending on the clones
and in accordance with the numbers of trees opened



The Lima Puluh multi-clonal trial has been opened since January 1991. Opening was only carried out in the replicates where over 50% of trees had a diameter of over 50 cm. Hence, only 15 out of the 26 clones had their 4 replicates opened in October 1991. The production analysis is based on these 15 clones. They are all in the first growth group at Lima Puluh.

The records are monthly and concern production per block (one clone, one replicate, i.e. 80 initial trees). In each of the blocks there are both dead trees and unopened trees. Finally, the production of border trees is not taken into consideration, so as to avoid interaction between blocks. Hence, on average, production records only involve 33.85 trees/block.

The tapping system is S2/D4, with 4 stimulations per year with ethephon at a rate of 70 mg of a.i./tree.

Measurements are taken during the first tapping each month. The production is collected from each block and dried in the open air for 21 days, then weighed.

The analysis carried out on the average of the first 9 records is shown in figure 11. Mean production per tapping per block varies from 95.44 kg for RRC110 to 84.56 kg for TM9. The analysis of variance reveals the existence of a highly significant clone effect.

The Newman and Keuls test brings out two groups. Thirteen out of 15 clones are included in the first production group. Nine of them are included in the first growth group at Aek Pamenkie and Lima Puluh. Clones PR255, RRIM703, TM6 and PR303 are not included in the first growth group at Aek Pamenkie.

The graph showing production per block depending on the number of trees in each block reveals the existence of a tendency towards increased production as the number of trees increases (figure 12). However, the correlation between production and the number of trees is not strict (r = 0.42, DF = 13, probability = 11%, not significant). Production in clone TM9 blocks remains low, despite a large number of trees. On the other hand, production in the PB235 blocks is high, whereas the numbers of trees are small.

It should be noted that the small number of trees in the PB235 blocks does not stem from low growth in this clone, from numerous missing trees.

When the number of trees is known per block, an analysis can be made of average production per tree depending on the clones (figure 13). Average production per tapping per tree varies from 45.29 g for PB235 to 18.20 g for TM9. An analysis of variance reveals the existence of a highly significant clone effect.

Figure 13: Analysis of mean production per tree per tapping, depending on the clones (during the first 9 months), based on the mean weights of the latex collected and dried in the open air for 21 days (S2/D4; stimulation with ethephon at the rate of 70mg of a.i./tree in June) in the Lima Puluh multi-clonal plot.

A. Analysis of variance

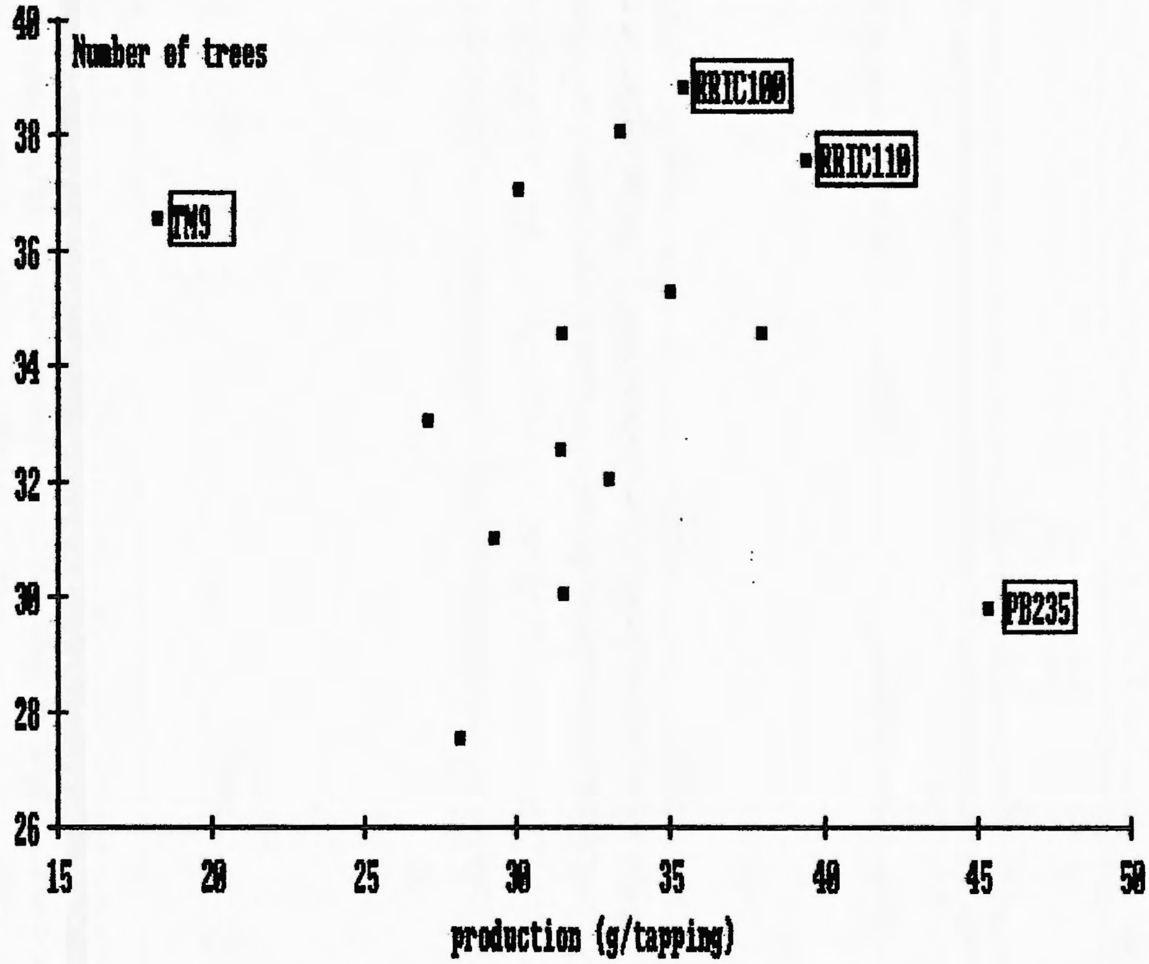
VARIANCES	S.C.E.	D.f.	F TEST	Prob.	C.V.
Total	4540	59			
Clones	2116	14	2.90	0,0039	
Blocks	235	3	1.50	0,2276	
Residual	2190	42			25.4%

B. Clones classification (NEWMAN-KEULS test)

	Clone	Mean production/ tapping/tree (g)
1	PB235	45.29
2	RRIC110	39.40
3	RRIM717	37.93
4	RRIC100	35.40
5	PB260	34.99
6	BPM107	33.34
7	PR255	33.01
8	TM6	31.51
9	BPM1	31.48
10	RRIC102	31.41
11	RRIC101	30.02
12	RRIM703	29.25
13	TM8	28.13
14	PR303	27.08
15	TM9	18.20

(*) without border trees

Figure 14: Mean tree production depending on the clones and in accordance with the numbers of tree oppened



The Newman and Keuls test brings out two groups. Thirteen out of 15 clones are included in the first production group. They are the same as those classified in the first group for production per block, apart from clone TM8 which replaces clone PR303.

The graph for production per tree depending on the number of trees in each block reveals the existence of a strong tendency towards increased production as the number of opened trees increases (figure 14). This reflects the relation between strong growth and good production. However, the correlation is not significant (r = 0.01, DF = 13, probability = 97%, not significant). The particular characteristics of clone TM9, high growth but low production, should be noted once again.

Conclusion

Out of the 26 clones tested, nine are always classed in the first group, either at Aek Pamenkie for growth, or at Lima Puluh for growth and production. These are: PB235, PB260, RRIC100, RRIC101, RRIC102, RRIC110, BPM1, BPM107 and RRIM717.

Average production at Lima Puluh in the first nine months following opening, after drying in the open air, was around 40 g/tapping/tree. Drying in the open air is definitely not completed and true dry rubber production should be a little lower than the figures indicated. However, these production levels remain good for a first production year.

Foliage density records confirmed the higher disease incidence at Aek Pamenkie. These diseases are probably partly responsible for the late start to tapping compared to Lima Puluh. However, leaf diseases are only one factor among others and cannot explain the entire delay. In fact, if leaf diseases were the only factor involved, the growth of resistant clones should be equivalent on both estates.

One of the clones proved to be particularly resistant to *C. gloeosporioides* and *Oidium heveae* epidemics, which developed at Aek Pamenkie in 1991 - clone RRIC100. It does not appear to have a total lack of susceptibility to parasite attacks, since the leaves often have characteristics lesions, though they are less numerous than on the other clones. The good performance of RRIC100 seems to be due more to a blockage or very strong slowdown in the epidemic process.

The other eight clones in the first group revealed moderate levels of resistance to leaf parasites in 1991. Their growth is not significantly different from that of RRIC100.

The susceptibility of clones TM6, PR255, TM9, PR303 and RRIM712 to leaf parasites may be responsible for their poorer classification under Aek Pamenkie conditions, compared to their classification under Lima Puluh conditions.

The production records in 1992 will be particularly worth monitoring, so as to determine the incidence of leaf diseases on production.

TRUNK DISEASES

The most worrying trunk disorder cause on the SOCFINDO estates is brown bast phenomena. The most serious damage is recorded in plantings over 10 years old, particularly those planted with clones GT1 or AVROS 2037. However, the disease may also occur very early.

The first external signs of the disease are the appearance of cracks in the bark at the base of the trunks (photo 5). When the damaged bark is scraped away, brown patches can be seen in the underlying tissue (photo 6). This necrosis of latex bearing tissue is behind the drop in latex production. The cracks and brown patches spread rapidly round and up the trunk. Production stops totally when the tapping panel is reached.

In the absence of any precise recommendations for controlling this infection, SOCFINDO scrapes away the necrotic parts and carries out two spraying operations a week apart with a solution of 0.5% De Rosal (a.i.: carbendazyme) (photo 7), and finally applies Anthio protective grease.

This method clears up external symptoms and at first glance seems to be very effective. However, in all the cases examined in detail in the field, it seems that the cracking phenomenon recurs as soon as the new bark forms (photos 8 and 9). Once tapping is resumed, around a year later, very sudden production drops are seen in the great majority of cases.

As already reported in other regions, brown bast development does not appear to be random in plantations, but in groups of two or three trees in the same row (photo 10). This distribution along the planting row has led to the hypothesis that a virus type pathogen is involved in this disease.

Development of effective control methods requires an in-depth study of this virus hypothesis, particularly the identification of the propagation method(s). IRCA is working on this subject, but this research is complicated and practical applications cannot be expected in the near future.

Photo 5: Cracks in the bark at the base of the trunk

Photo 6: Brown patches in the underlying tissues

Photo 7: Treated tree

Photo 8: Cracking phenomenom on the new bark

Photo 9: Cracking phenomenom on the new bark

Photo 10: Brown bast development in plantations