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MISSION TO THE RSUP COCONUT PLANTATION
PULAU BURUNG / SUMATRA / INDONESIA
24th August to 13th September 1998

Study on the role of *Sufetula sunidesalis* in stagnating PB 121 hybrid coconut yields

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CP SIC 1030bis

October 1998

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MISSION SCHEDULE

Monday 24 August 1998 :	Departure from Montpellier /morning
Tuesday 25 August 1998 :	Arrival at RSUP, afternoon
Wednesday 26 August 1998:	Tour of trial RS-CC 07/RSTM with Messrs Lilik, Husni and Bonneau. Establishing work programme for the following days.
Thursday 27 August 1998 :	Visit to the rhizotrons in A07-02. Afternoon: preparation and installation of traps.
Friday 28 August 1998 :	Checking of traps, then root sampling in trial HSF 15 / A07-02. Afternoon: general meeting before X. Bonneau's departure, with Messrs Lilik, Nharong, Sam Pak Lam, Husni, and Rahmat, RSUP assistants and managers.
Saturday 29 August 1998 :	Checking of traps, then root sampling in trial HSF 15 / A07-01.
Sunday 30 August 1998 :	Checking of traps and data recording.
Monday 31 August 1998 :	Checking of traps, then root sampling in trial HSF 15 / A07-01 (termination). Afternoon: preparation of new traps and installation in plot K03-01. Evening: trapping trial with an actinic tube and a Wood tube in the plot behind the laboratory.
Tuesday 1 Sept. 1998 :	Root sampling in trial HSF 10 / A07-01 and nut counting in trial HSF 11 / HSF 02. Tour of two young plots. Checking of traps in the afternoon. Rearing of *S. sunidesalis* larvae on an artificial medium.
Wednesday 2 Sept. 1998 :	Root sampling in trial HSF 10 / A07-01 (termination) and nut counting in trial HSF 11 / HSF 02 (continued). Checking of traps. Checking of the nursery plants used for rearing *S. sunidesalis*. Evening: trapping with a Wood tube from 6:30 pm to 8:30 pm.
Thursday 3 Sept. 1998 :	Root sampling in trial HSF 11 / A07-02. Procurement of cocopeat as infill in the planting circles of coconut palms whose roots were exposed again in trial HSF 14 / RS-ES 74 / A07-01. Heavy rainfall from around 11:00 am till midnight..
Friday 4 Sept. 1998 :	Laying of cocopeat at the foot of the coconut palms. Checking of traps. Trapping in the evening with an actinic tube.

Saturday 5 Sept. 1998 :	Laying of peat at the foot of the coconut palms. Checking of traps.
Sunday 6 Sept. 1998 :	Data recording.
Monday 7 Sept. 1998 :	Root sampling in trial RS-ES 57. Checking of traps.
Tuesday 8 Sept. 1998 :	Tour of two 15-months-old plots at RSTM.
Wednesday 9 Sept. 1998 :	Root sampling in trial RS-ES 57 (termination).
Thursday 10 Sept. 1998 :	Final checking of traps and verification of a few captured insects. Drafting of the work programme for the Entomology Service and recap of trial results for the Friday Afternoon meeting.
Friday 11 Sept. 1998 :	Checking of the cocopeat and coconut husk laying work in trial HSF 14. Recap of trial results for the afternoon meeting with those in charge of the Plantation.
Saturday 12 Sept. 1998 :	Departure for Singapore.
Sunday 13 Sept. 1998 :	Departure for Montpellier.

ACKNOWLEDGEMENTS

Sincere thanks to all the people in charge at RSUP, particularly Messrs. Sam Pak Lam, Lilik Qusairi, along with all the managerial staff, Messrs Husni, Rachmat and members of the Crop Protection and Agronomy Services, for their warm hospitality, for the time they gave up and for their kind and friendly collaboration, which facilitated the smooth running of the mission.

SUMMARY

This mission was used to take stock of the trials set up during earlier missions. There seems to have been more *S. sunidesalis* attacks in 1998 than the previous year.

There are currently two effective contact insecticides: Dursban and Supracide; they provide satisfactory protection for the root system from *S. sunidesalis*. Protection does not last a month, since fresh attacks are found on reiterations, despite monthly treatments with the insecticides. Heavy rain causes substantial leaching of these insecticides. Nonetheless, insecticide tests should be continued to try and find other molecules, available in Jakarta, which will need to have the following qualities: good resistance to leaching, long persistence, systemic via the root system, though without undergoing perfect translocation via the sap, up to the leaf crown, with low to moderate toxicity. The aim is to define, if possible, rational control in clearly defined situations. Obviously, it does not mean systematically treating all the plots in the plantation.

Thus, at the end of a year and half, monthly insecticide treatments have still not led to any improvement in coconut yields, although the root system gradually improves.

The same goes for the treatments with layers of cocopeat and coconut husks, which only act by reducing *S. sunidesalis* attacks on the roots. However, they offer the advantage of maintaining satisfactory humidity in the upper layer of soil (20 to 40 cm), which was found to be very dry during the last mission.

Rearing of *S. sunidesalis* on an artificial medium or in sleeves on young coconut palms is proving to be very difficult. It is always difficult to find a large number of larvae at a given time. A large number of labourers have to be used to examine the roots of germinated nuts in the plantation; there is then a greater chance of obtaining larvae.

Light trapping with UV tubes did not lead to many *S. sunidesalis* captures. The first tests of three attractants have not given positive results. Otherwise, it has not been possible to detect the existence of a pheromone in *S. sunidesalis* females. Trapping trials will be continued with other attractants.

As regards biological control of this pest, two experimental avenues can be explored: the use of nematodes and entomopathogenic fungi. Feasibility studies are under way in collaboration with researchers from the national agronomic research institute.

Observations clearly tend to show that maintaining bare soil right from the start of planting, effectively reduces *S. sunidesalis* attacks on coconut palm roots, especially primary roots. Attacks can begin very early, and the current effect on coconut yields most probably results from a cumulation of attacks during coconut palm development. Thus, the following strategy can already be adopted for new plantings or future replantings: good compaction of the soil for new plantings and perfect weeding; bare soil should be maintained for the first five years. Thereafter, mulching can be carried out with cocopeat or small fragments of coconut husks in a 2 m circle around the coconut stems, to help maintain a certain degree of moisture in the surface horizon and prevent erosion at the foot of the coconut palms.

INTRODUCTION

During the previous mission (CP SIC 914, March 1998), undertaken at the end of 1997, it was confirmed that attacks by *Sufetula sunidesalis* caterpillars were effectively responsible for the low coconut yields at RSUP in Pulau Burung. Indeed, large holes dug at the foot of good and poor yielders, aged 10 years, showed that root elongation was limited: 1 to 3 m, rarely more, rather than 7 to 9 m for palms of the same age under non-limiting conditions. The root elongation rate is apparently very slow. Moreover, it is surprising to see the existence of a dry zone spreading over a radius of 80 cm around the stem and down to a depth of 30 cm, whilst the water table is only 1 m down. Most of the tertiary and quaternary roots, which are the most absorbent ones in the root system, are found in that zone. Lastly, this dry zone has also been found just beneath the stem, down to a depth of 80 cm in some palms, inside the plot. There is also severe soil erosion following heavy rainfall, in a 2 m radius around the stem. This erosion process goes hand in hand with natural compaction of the peat, which all leads to a typical mound at the base of the coconut palms. The superficial roots, which are primarily absorbent roots, are uncovered, dry out in the sun and are also more easily attacked by the caterpillars.

However, the caterpillars of this species are most probably not the cause of the very substantial heterogeneity affecting the growth of these coconut palms. By ten years, this heterogeneity results in some very tall coconut palms (over 7 m tall), some moderately sized palms (5 to 6 m) and smaller palms (2 to 3 m). All these three categories are attacked to varying degrees by the caterpillars, which partly prevents the establishment of a correlation between the rate of caterpillar attacks and the number of nuts. However, it has been possible to show that there is a good triangular relation between coconut palm height, the fresh weight of their roots, and the number of nuts borne by the coconut palms.

It is also apparently difficult to establish a good relation between caterpillar attacks and coconut yields, since the cumulative effect of the attacks cannot be accurately measured; indeed, these attacks are not severe, sudden or limited in time and space. They are rather slight in general and occur on a regular and continuous basis over months and years. The generations overlap.

The *Sufetula* development cycle lasts 38 days. The larval cycle takes place entirely in the soil; pupation occurs either outside or inside the roots. It is therefore very difficult to reach the caterpillars directly for insecticide treatments, meaning that it is very tricky to accurately assess the true biological effectiveness of the toxic molecules.

A new trial was set up in December 1997 on *Sufetula* control, to improve the degree of humidity near the soil surface and reduce erosion: covering of soil up to 2 m around the stem with coconut husks, with or without insecticide treatment - covering of soil up to 2 m around the stem with "cocopeat" (residues of husk fibre removal), with or without insecticide treatment -insecticide treatment alone - control without circle cleaning.

EFFECT OF *Sufetula* (*Lepidoptera - Pyralidae*) ATTACKS ON COCONUT YIELDS AT RSUP

I. STUDY OF *S. sunidesalis* POPULATION DYNAMICS

I.1. Method

Monthly samples are now taken in 100 x 40 x 40 cm holes 1 m away from the stem, along the coconut planting row, to the North or to the South. Ten palms were chosen at random in 4 plots aged 6 to 10 years. The rate of new attacks is calculated as follows: number of new attacks over the total of healthy roots and of newly attacked roots.

I.2. Results

It can be seen in figures 1 to 4 that *S. sunidesalis* attacks in 1998 are generally greater than in 1997.

The attack peaks are in no way determined in advance from one year to the next in most of the 4 observation plots:

- In K03-01, a peak was seen in June 97, then in January and July 98.
- In A06-03, a peak was seen in April, June and July 97, then in January, February, April, May, June and July 98.
- In A09-08, a very small population was seen in 97, followed by a rise in January, April, June, July and August 98.
- In B11-09, there was a very small population in 97, as in the previous plot, then a rise in January; April, June and August 98.

These observations are interesting in more ways than one, since they prove that adult emergence is highly staggered in time. Generations therefore overlap, which proves that female egg-laying periods are not at all synchronous. In one way, they confirm the results of trial HSF 09 relative to adult emergence (see section IV hereafter).

II. *S. sunidesalis* BIOLOGY

So far, no mortality has been observed for the caterpillars of this pest resulting from the effect of a given biotic agent, namely parasitoids, predators, fungi and entomopathogenic viruses or other organisms such as nematodes.

On three other species of *Sufetula* that cause damage to oil palm aerial roots, no parasitoid or predator has been found on the larvae of *S. diminutalis* in Colombia and Peru, or on those of *S. nigrescens* in West Africa. However, on the larvae of *S. sunidesalis,* which attack oil palm aerial roots in northern Sumatra, a single pupa parasite has been found in the soil: a chalcid *Haltichellinae* of the genus *Antrocephalus* Kirby.

Figure 1 : Population dynamics of *Sufetula sunidesalis* in K03-01

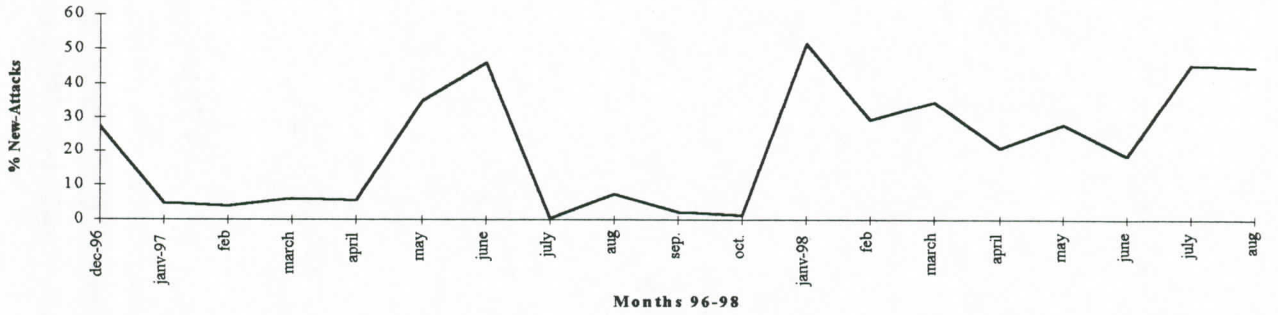


Figure 2 : Population dynamics of *Sufetula sunidesalis* in A06-03

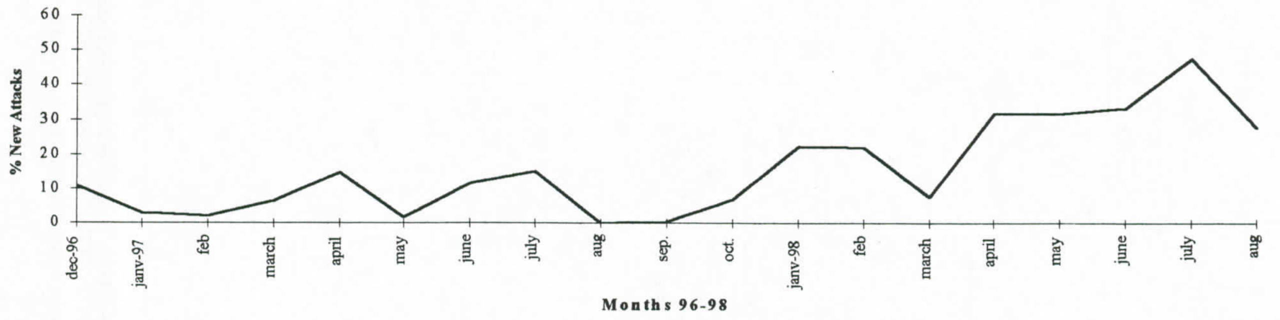


Figure 3 : Population dynamics of *Sufetula sunidesalis* in A09-08

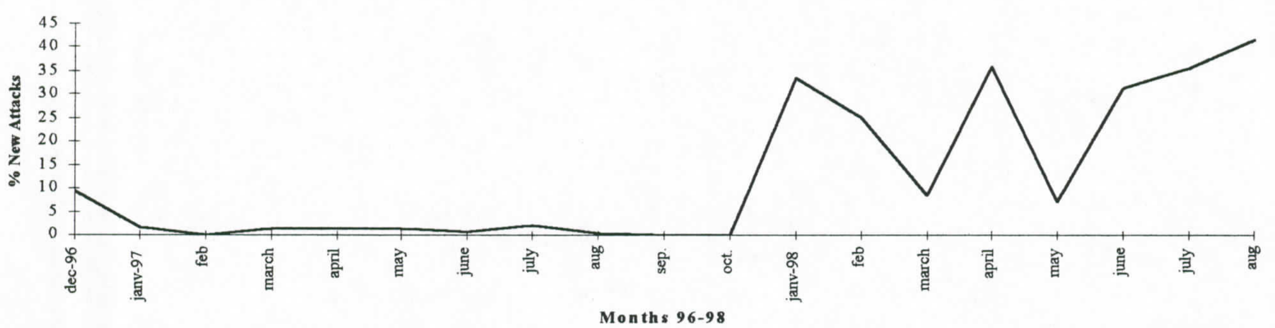
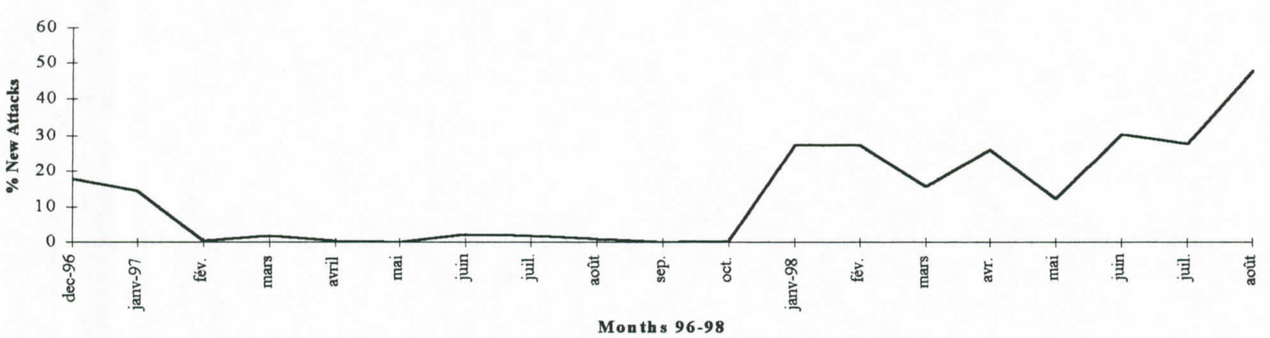


Figure 4 : Population dynamics of *Sufetula sunidesalis* in B11-09



On another species of caterpillar mining underground oil palm roots in Colombia, *Sagalassa valida* Walker of the family *Glyphipterigidae*, no parasite or entomopathogenic organism has yet been identified.

Nevertheless, there are two experimental avenues being explored in the field of biological control of this type of pest: use of nematodes and entomopathogenic fungi. Feasibility studies are under way in collaboration with researchers from the national agronomic research institute.

III. ANALYSIS OF THE RESULTS IN TRIAL HSF 05

III.1. Purpose

Will stepping up protection against *Sufetula* enable significant and sustainable regeneration of the root system, and a reduction in LBL symptoms (premature drying out of Lower Bunches and Leaves), in other words an improvement in the number of green fronds and the bunch load.

III.2. Reminder of the protocol

This trial, which is located in plot A06-03/RSUP (where *S. sunidesalis* pressure is very strong) only comprises 10 treated coconut palms and 10 controls with clean circles, along with 10 others with weedy circles. The trial was launched in December 1996. Protection consists in spreading a black plastic sheet over a radius of 2 m around the stem, to prevent the moths from laying their eggs. In addition, Dursban has been sprayed at standard dose and concentration, by lifting the plastic sheets, every month or every fortnight since June 1997 (Desmier de Chenon and Bonneau, DOC. CP 678/96, p.9).

III.3. Results

The bunches at frond No. 10 on all the palms selected for the trial were marked before and after treatment; then the bunches were monitored to see what became of them in the months following marking. Table 1 gives the percentages of fruits remaining in the bunches when the marked leaves had reached rank 14 (3 months after marking), then rank 19 (6 months after marking). A year later, no difference was found between the control palms and the treated palms for the number of nuts remaining at leaves 14 and 19. This result would seem to be due to the fact that the plastic sheets were very often torn and were not immediately replaced. It can be seen in table 2 that the coconut palms with clean circles are now as infested as those with weedy circles. Reinfestation is easy in this small trial.

Comment: Thus, in view of these results, it would be wise to halt this trial, though it did show that artificial covering of the soil can prevent *S. sunidesalis* from reaching the roots, even if the females laid their eggs on the plastic sheets. In fact, it is seen that primary roots particularly, the secondaries, then the tertiaries are clearly less severely attacked on the coconut palms protected by plastic sheets than on the controls (Table 2).

Table 1: HSF 05 / A06-03 - Effect on coconut yields of protecting against *S. sunidesalis* using plastic sheets and insecticide treatments

Period	Number of nuts / L10	% fruits remaining in bunches of leaves	
		L14	L19
Before treatment			
Treated	17	16.97	16.97
Control	13	22.83	15.75
1 year later			
Treated	20	37.4	34.3
Control	14	43.1	39.6

Table 2: HSF 05 / A06-03 - Effect on root attacks of protecting against *S. sunidesalis* using plastic sheets and insecticide treatments

Treatments / Dates	% new attacks on roots			Means
	Primary	Secondary	Tertiary	
With plastic sheets and treatments				
12/02/98	1.9	0.5	0	0.1
13/05/98	12.5	31.4	13.5	14.5
10/08/98	0	24.2	10.3	10.4
Control with clean circles				
12/02/98	48.6	45.1	34.1	35.5
13/05/98	25.5	27.1	24.4	24.5
10/08/98	29.2	51.8	25.3	26.3
Control with weedy circles				
12/02/98	27.2	23.2	12.2	14.1
13/05/98	23.9	20.3	22.0	21.7
10/08/98	69.4	40.0	34.7	36.7

IV. ANALYSIS OF ADULT *S. sunidesalis* EMERGENCE UNDER NATURAL CONDITIONS HSF 9

Next to trial HSF 05, another similar test was set up on 18th June 1997, HSF 09 / A06-03 / RSUP, with square transparent plastic sheets measuring 6 m x 7 m, laid around 10 coconut palms. No insecticide treatment was carried out. Every week, the ten transparent plastic sheets were removed to collect and count all the *Sufetula* adults found. The sheets were then put back in place.

Figure 5 shows that weekly adult emergence was very low to average on each coconut palm. In addition, emergence was not regular from one palm to the next, and from one week to another. That suggests the overlapping of several generations resulting from staggered and random egg laying, which has been confirmed, moreover, by observations of population dynamics in 4 plots. The low adult emergence over time and the existence of a severely attacked root system on 10-year-old coconut palms also suggests that each caterpillar attacks several roots during its development. Moreover, attacks by these caterpillars accumulate on the root system over the years.

In this case, the transparent sheets, which may have been thicker than in trial HSF05, resisted sunlight better and protection from *S. sunidesalis* seemed much better than in the previous trial HSF 05: root attacks are fewer on average than in the control (Table 3).

Comment: After around a year, the emergence data have been recorded and we now know the frequency of adult emergence from one coconut palm to another. Hence, this trial should now be halted. As in the previous trial, no conclusive effect will be found on long-term yields as too small a number of coconut palms is involved (Table 4). Moreover, it was not the initial purpose of this trial, HSF 09.

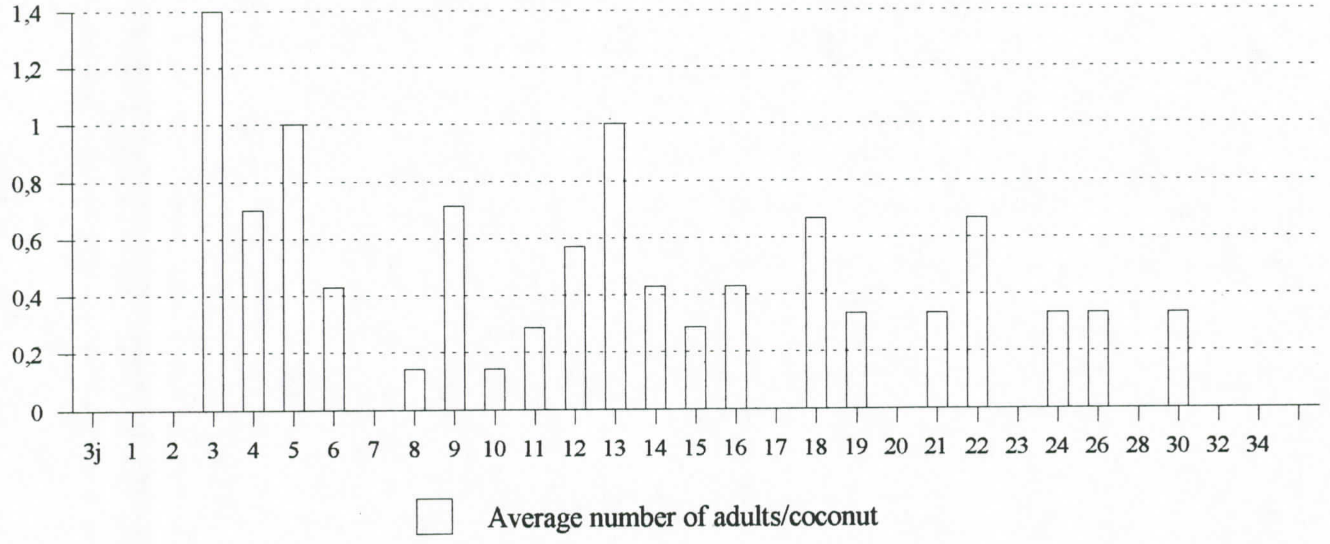
Table 3: HSF 09 / A06-03 - Effect on root attacks of protecting from *S. sunidesalis* using plastic sheets only

Treatments / Dates	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
With plastic sheets				
12/02/98	4.5	3.0	0.3	0.6
20/05/98	4.3	7.5	0	1.1
23/08/98	0	3.6	0	0.5
Control with clean circles				
12/02/98	24.7	6.6	1.0	2.3
20/05/98	27.4	20.8	2.0	4.0
23/08/98	48.0	61.3	13.0	15.6

Table 4: HSF 09 / A06-03 - Effect on coconut yields of protecting from *S. sunidesalis* using plastic sheets only

Treatments	Month	Number of palms	Average number of nuts at			
			L10	L14	L15 to L28	L11 to L28
Control	June 97	10	19	7	59	123
	October 97	10	17	7	76	125
	February 98	10	17	7	73	112
	May 98	10	17	3	64	91
	August 98	10	15	1	60	86
With plastic sheets	June 97	7	19	7	53	108
	October 97	7	14	5	60	103
	February 98	10	17	5	62	90
	May 98	10	16	4	62	92
	August 98	10	14	2	48	71

Figure 5 : Analysis of adults S. sunidesalis emergence in A06-03



V. Insecticide tests: HSF 10 / A07-01 / RSUP

V.1. Purpose

The purpose is to find a more effective and, especially, more persistent insecticide than Dursban.

V.2. Material and method

Treatments began on 26th June 1997. A first set of results was mentioned in the November-December 97 mission report (CP SIC 914). Given the results obtained, we changed the experimental design in November 1997, replacing two of the treatments (D2 = Dursban every two weeks and DM = Dimacide) in this trial to test doses of Larvin (L) and Supracide (SU):

L2, to replace D2, 12 ml of Larvin / 6 litres of water / coconut palm every month

SU2, to replace DM, 20 ml of Supracide / 6 litres of water / coconut palm every month

The other treatments (D1 Dursban, L Larvin, SU Supracide, every month, Control) remain unchanged (Figure 6).

Root samples are currently taken on two coconut palms in each elementary plot, in a 1 m x 40 cm x 40 cm hole dug in the planting row, 1 m from the stem of each sampled coconut palm. Remember that "new or recent attacks" refers to roots bearing galleries containing living caterpillars or more or less oxidized caterpillar excreta. Reiteration consecutive to such an attack is not yet noted. "Healthy roots" refers to all root fragments sampled that reveal a healthy apex, irrespective of the reiteration length.

IV.3. Results

Dursban satisfactorily protects coconut palm roots from new *S. sunidesalis* attacks, but the impact of such protection on yields remains to be analysed.

Supracide gives similar results to those with Dursban, but it is curious to see that with a double dose root system protection is no better.

Larvin does not give very satisfactory results at a dose of 6 ml per coconut palm and, at the double dose, the results remain heterogeneous and little different from those of the control, as shown in the root samples in September 98 (Table 5). Moreover, Larvin is no longer available in Jakarta.

So, for the time being, two contact insecticides are available that provide satisfactory root protection, but they are inconsistent and non-permanent. This undoubtedly results from rapid leaching of the active ingredients by abundant rainfall, depending on the month of the year.

Comments: This trial will need to be continued for at least another 6 months to check the effectiveness of a dose of 20 ml of Supracide alone, in two different volumes: 6 and 3 litres of water per coconut palm. Figure 7 shows the changes made to the previous experimental design.

Figure 6 : A 07- 01 - HSF 10 - RSUP - Trial of three insecticides

D1	**15 ml Dursban / 6 litres of water / palm**	**Every month**
L2	**12 ml Larvin / 6 litres of water / palm**	**Every month**
L	**6 ml Larvin / 6 litres of water / palm**	**Every month**
SU2	**20 ml Supracide / 6 litres of water / palm**	**Every month**
SU	**10 ml Supracide / 6 litres of water / palm**	**Every month**
C	**Control without cleaning circle around palms**	

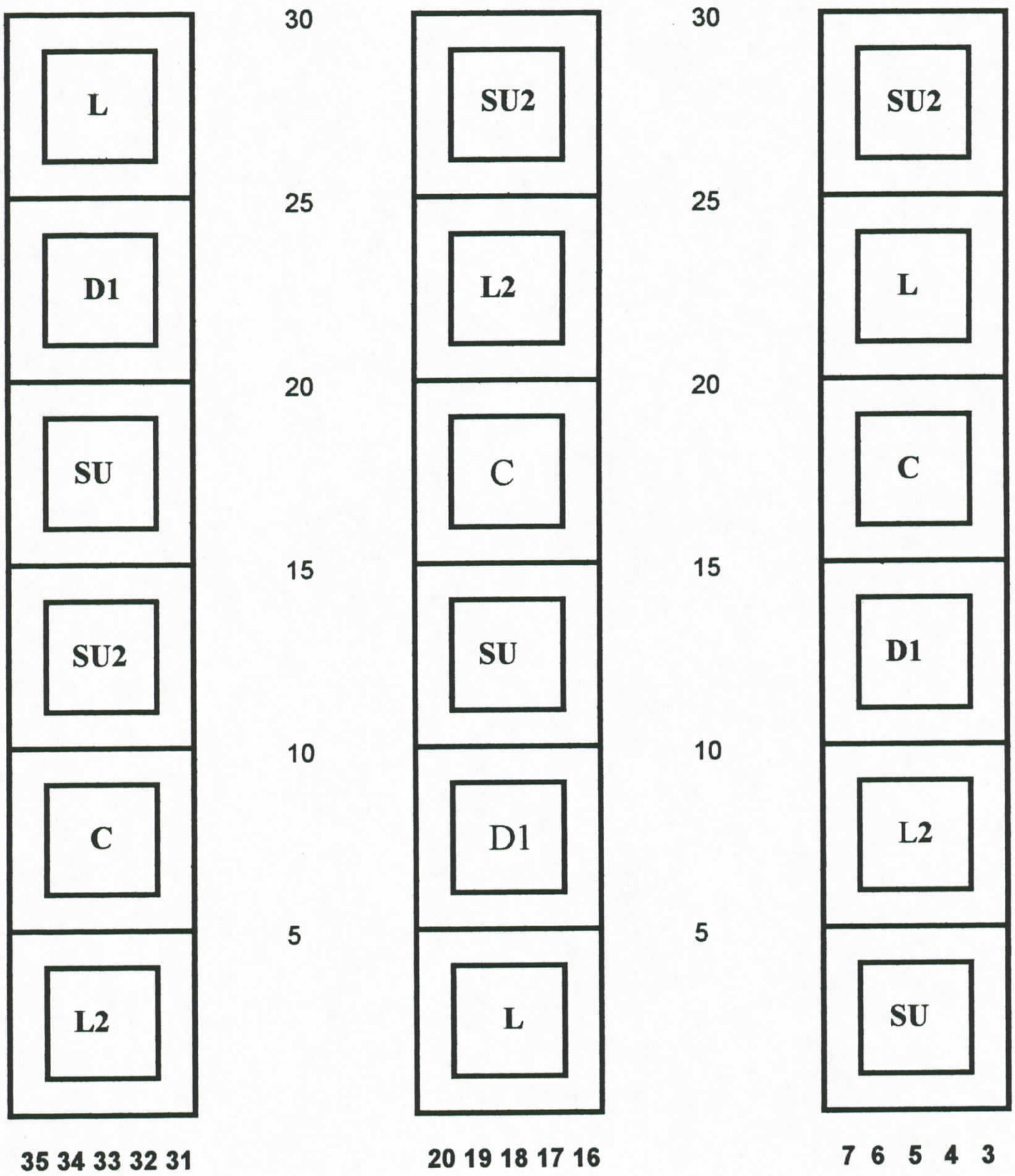


Figure 7 : A 07- 01 - HSF 10 - RSUP – Test of one dose of Supracide (20 ml) with two volumes of water (SU = 3 litres and SU_2 = 6 litres of water)

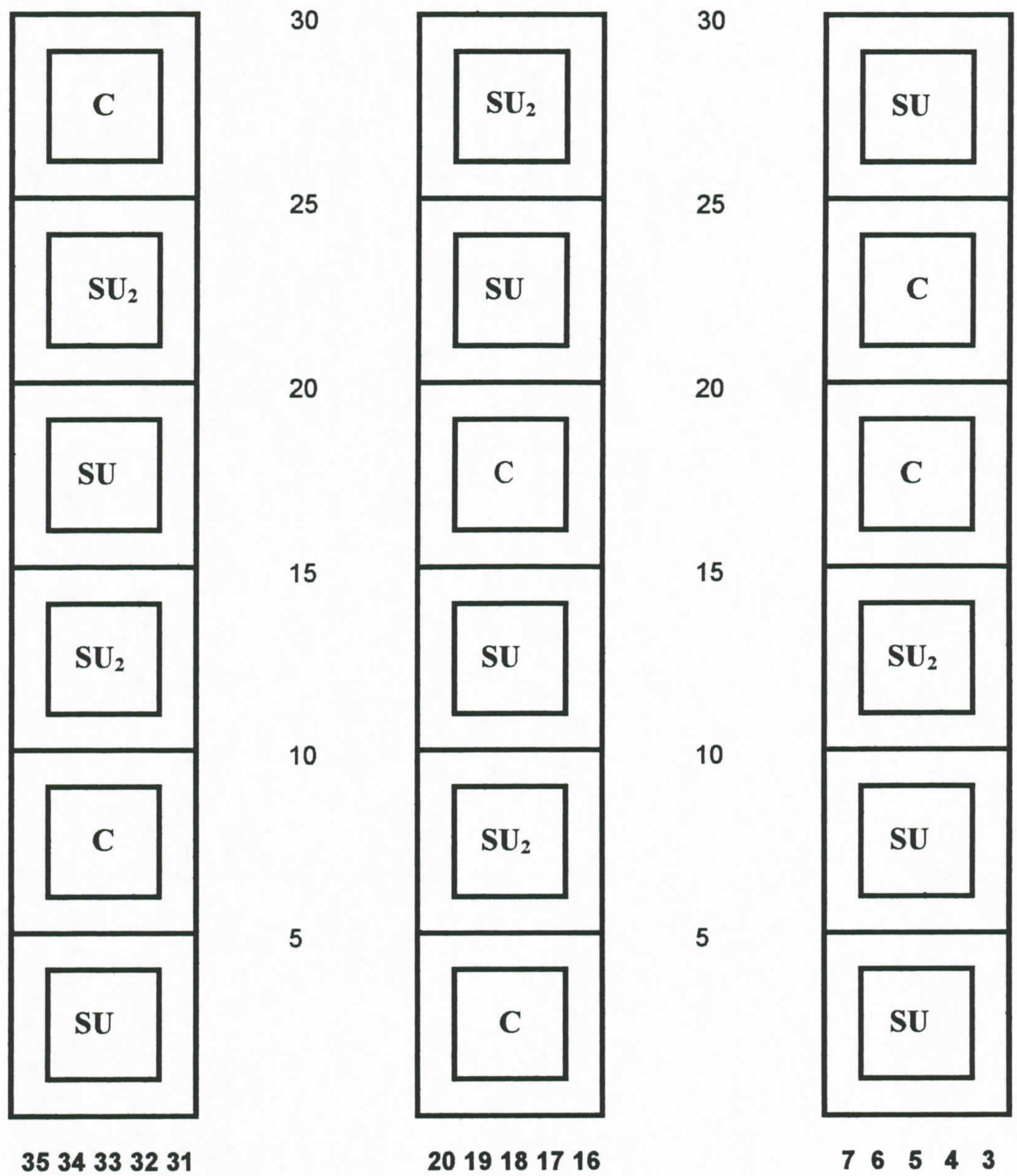


Table 5: HSF 10 / A07-01 - Effect of protecting roots from *S. sunidesalis* attacks using insecticides

Treatments / Dates	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
Supracide 10 ml/6 l of water/coconut palm				
March 98	4.7	4.6	0	0.4
June 98	0	0	0	0
September 98	12.2	6.7	1.8	3.1
Supracide 20 ml/6 l of water/coconut palm				
March 98	5.1	3.4	0.3	0.8
June 98	0	0	0	0
September 98	32.1	14.6	2.4	6.3
Larvin 6 ml/6 l of water/coconut palm				
March 98	16.7	2.2	0.3	0.8
June 98	14.3	1.4	1.0	2.2
September 98	8.1	9.2	5.1	6.7
Larvin 12 ml/6 l of water/coconut palm				
March 98	4.2	4.2	0.4	0.6
June 98	0	0	0	0
September 98	20.8	9.1	3.9	6.1
Dursban 15 ml/6 l of water/coconut palm				
March 98	0	1.9	0.5	0.6
June 98	0	0	0	0
September 98	10.7	9.1	1.6	3.0
Control				
March 98	7.1	12.5	1.6	2.2
June 98	21.1	8.6	2.4	4.4
September 98	72.4	13.5	3.8	7.6

VI. Effect of *Sufetula* attacks on yields: HSF 11 / A07-02 / RSUP

VI.1. Purpose and reminder

The aim is to demonstrate that frequent chemical treatments at high doses can lead to an effective and significant increase in yields through recovery of a healthy root system.

VI.2. Material and method

The treatments have started from june 1997. Given the results presented in the November-December 97 mission report (CP SIC 914), we modified the experimental protocol, replacing treatment D2 (= Dursban every 2 weeks) in this trial to test the spraying volume: 3 litres of solution instead of 6 litres applied every month in a circle with a radius of 2 m around each coconut palm. The other treatments (D1 Dursban, every month, Control) remained unchanged (Figure 8).

The nuts on the coconut palms were counted before the treatments, then every three months thereafter. From January 1999 onwards, the Agronomy service will collect the ripe nuts to estimate the true yields from the different treatments.

VI.3. Results

Table 6 shows that a spraying volume of 3 litres per coconut circle with a radius of 2 m can be used. The protection of roots treated every month with Dursban against *S. sunidesalis* attacks is real but not permanent. This result may be due to the fact that the insecticide does not resist leaching by heavy rain, despite the presence of a sticker.

As nut-load heterogeneity is very marked from one coconut palm to another, grouping was carried out by palm height category (Table 8). However, no difference has yet been seen between the treated palms and the control for the level of nut loads in the coconut palms (Tables 7 & 8).

Comments: This trial will need to be continued for at least another year, to ascertain any beneficial effect that root protection with a contact insecticide might have on yields. In the future, all the D1 and D2 treatments will receive a single dose and spraying volume: **30 ml Dursban / 3 litres of water / month/coconut palm.**

Figure 8 : A 07- 02 - HSF 11 - RSUP - Study of the effect of *Sufetula sunidesalis* on the production

D1	30 ml Dursban / 6 litres of water / palm	Every month
D2	30 ml Dursban / 3 litres of water / palm	Every month
C	Control without treatment nor cleaning the circle around the palms	

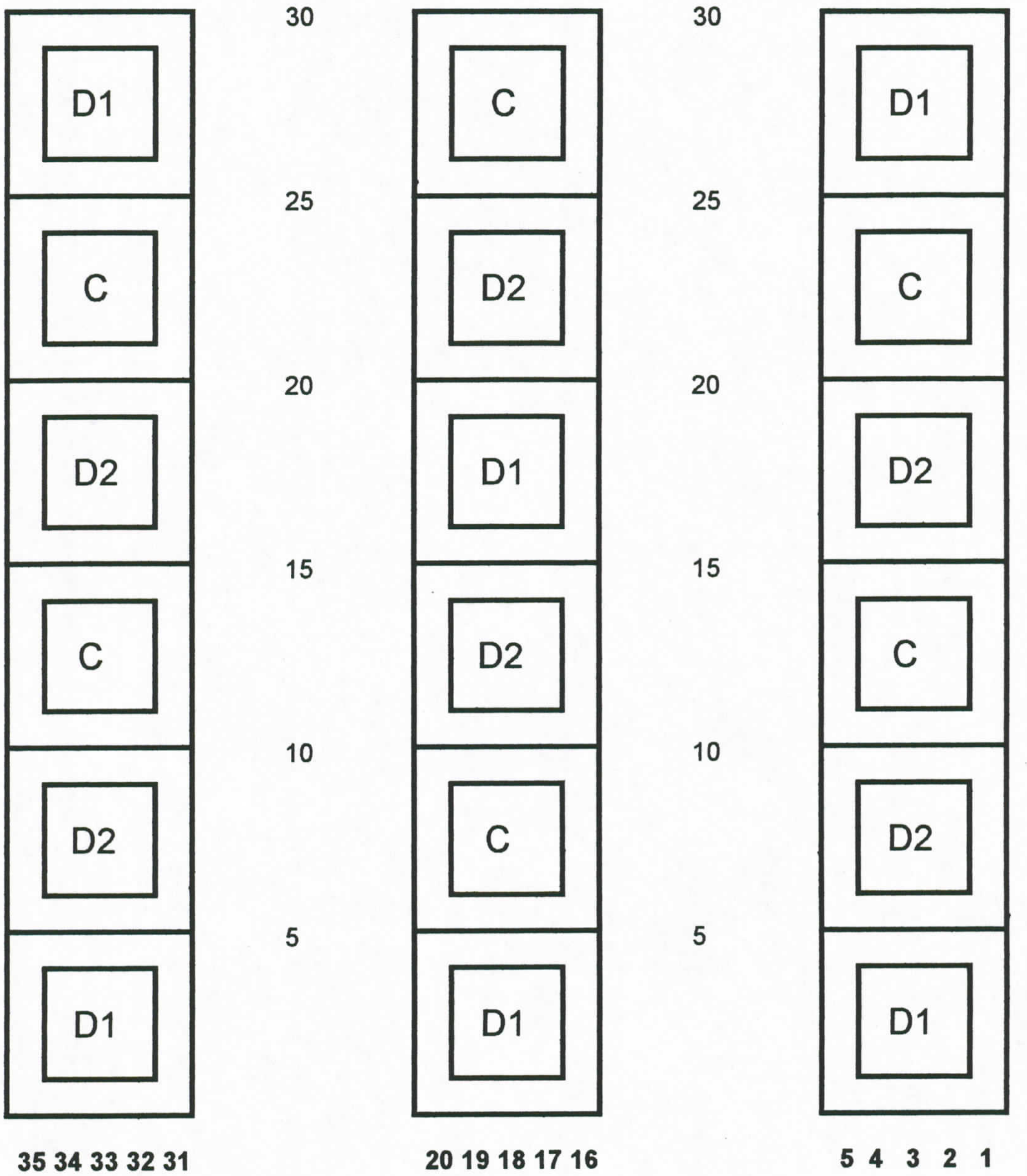


Table 6: HSF 11 / A07-02 - Effect of root protection from *S. sunidesalis* attacks using insecticides

Treatments / Dates	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
Dursban 30 ml/6 l of water/coconut palm				
March 98	5.1	1.7	0,.7	0.9
June 98	4.9	1.3	0.4	0.9
September 98	13.3	7.0	2.5	3.0
Dursban 30 ml/3 l of water/coconut palm				
March 98	0	0	0.7	0.7
June 98	0	0	0.2	0.2
September 98	23.4	9.8	2.4	3.3
Control				
March 98	10.6-	7.6	0.7	1.0
June 98	16.3	5.0	2.3	3.3
September 98	25.8	25.0	6.3	7.8

Table 7: HSF 11 / A0-02 - Effect on coconut yields of protecting from *S. sunidesalis* with insecticides only

Treatments	Month	Number of palms	Average number of nuts at			
			L10	L14	L15 to L28	L11 to L28
Dursban 30 ml/6 l of water/ coconut palm	June 97	39	17	6	48	84
	November 97	12	14	6	55	80
	March 98	12	15	6	57	84
	June 98	12	10	5	47	70
	September 98	39	11	4	50	74
Dursban 30 ml/3 l of water/ coconut palm	June 97	42	13	6	46	79
	November 97	11	11	4	53	71
	March 98	11	10	6	51	77
	June 98	11	10	4	53	73
	September 98	41	9	4	41	63
Control	June 97	38	17	5	61	100
	November 97	10	11	3	55	75
	March 98	10	11	6	51	78
	June 98	10	11	5	48	69
	September 98	35	9	5	51	74

Table 8: HSF 11 / A0-02 - Classification of coconut yields according to palm height

Treatments	**Average number of nuts / coconut palm at L11 to 28**					
Dursban 30 ml/6ml of water/palm	**2 to 3m**	**3 to 4m**	**4 to 5m**	**5 to 6m**	**6 to 7m**	**+ 7 m**
June 97		31	67	70	128	127
September 98		25	73	68	98	97
Dursban 30 ml/3ml of water/palm	**2 to 3m**	**3 to 4m**	**4 to 5m**	**5 to 6m**	**6 to 7m**	**+ 7 m**
June 97	12	45	73	99	116	
September 98	11	36	69	94	95	
Control	**2 to 3m**	**3 to 4m**	**4 to 5m**	**5 to 6m**	**6 to 7m**	**+ 7 m**
June 97	20	50	72	106	109	138
September 98	21	40	73	84	104	

VII. *Sufetula* REARING -HSF 12

Attempts to rear the larvae of this insect on an artificial medium containing 50 g of powdered coconut roots gave rise to pupae that did not develop into adults. During the mission, we tried two other media containing less powdered coconut root (40 and 20 g). A few 2nd and 3rd instar larvae managed to mine a gallery themselves in the medium.

In addition, adults were released into 4 mosquito netting sleeves installed over 4 young coconut palms. The plants were placed in the shade of the palms. The roots were checked on the plants and the results were as follows:

- Plant 1: numerous ants in the soil - 4 *Sufetula* attacks, no visible larvae
- Plant 2: a few ants in the soil - 5 *Sufetula* attacks, no visible larvae.
- Plant 3: a few ants in the soil - 10 *Sufetula* attacks, no visible larvae.
- Plant 4: numerous ants in the soil - 1 *Sufetula* attack, no visible larvae.

The rearing operation was not a success, since no succession of adult generations was seen in the sleeves.

So far, the *Sufetula* adults obtained from larvae collected from the primary roots of germinated nuts in the plantation correspond well to the description of *S. sunidesalis*. However, the adults caught in a butterfly net do not always correspond to *S. sunidesalis*. In fact, very few *S. sunidesalis* adults are caught in the afternoon.

VIII. LIGHT TRAPPING - HSF 13

Trapping sessions were carried out from 6:30 pm onwards, using two tubes emitting long UV waves: an actinic tube (near UV waves around 400 Å) and a black light tube or Wood tube (long UV waves, around 350 to 380 Å). In the plot just behind the laboratory, no *Sufetula* adults were attracted by the light. In addition, the very small number of insects attracted by the light is worth mentioning. This suggests that the entomofauna in the plant cover is not particularly abundant.

However, two other light trapping sessions were carried out, from 6:00 pm to 8:00 pm in K03 - 01, a plot near dwellings, so that the electricity supply could be used. In that plot, the insects attracted by the UV waves emitted by the actinic tube or Wood tube were much more numerous than in the previous plot: small Coleoptera, Microlepidoptera, Diptera, etc. With the actinic tube, only 2 males and 3 females *S. sunidesalis* were caught in 2 hours. With the Wood tube, captures were no better: 6 individuals attracted, 4 males and 2 females over the same length of time.

IX. SEARCH FOR A PHEROMONE IN *Sufetula* FEMALES

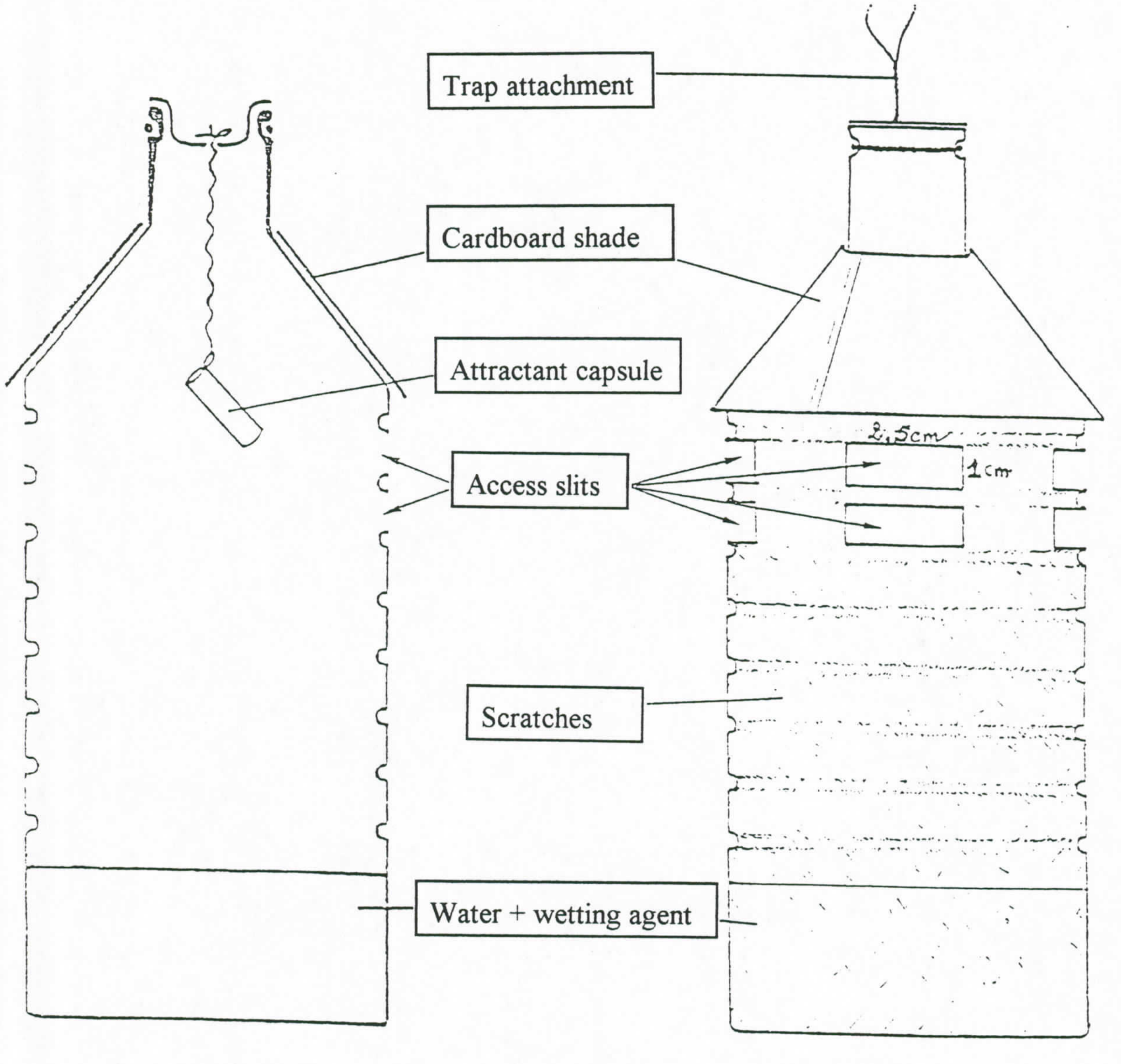
In December 1997, after 5 days' work with 2 to 4 operators per day, 289 larvae in the final two or three instars of development were collected from germinated nuts in the plantation. The larvae were brought back to Montpellier in root fragments. Forty-five pupae and 57 adults were obtained from the sample, i.e. a total of 102 individuals, which were sent to the Chemical Mediators Laboratory in Versailles (France), in two batches due to their staggered emergence. P. Zagatti, a specialist at the laboratory, only recovered 13 living females from the total set of adults, as all the pupae had been killed by the cold; the adults seem to have withstood the adverse conditions in transit better. A second sample of caterpillars was brought back to Montpellier by Xavier Bonneau at the beginning of March 98. It was sent immediately to P. Zagatti, who was able to collect the adults directly on their emergence.

The search for a pheromone in females drew a blank. However, electroantennography testing of a few attractants gave some results. The laboratory therefore supplied us with three substances (1 pure substance and two mixtures of the same substance with two others) presented in rubber capsule form: 6 capsules of each of the three substances.

A trapping scheme was suggested to us by the laboratory (Figure 9). The traps were made with two types of plastic water bottles: 0.5 and 1.5 litres. The first set of 3 compounds x 3 bottles was installed in plot K03-01, just opposite the laboratory, where the light trapping was carried out. The bottles are attached 20 to 30 cm from the ground, on a stake placed in the interrow in the middle of the vegetation, or in a cleared area . They are installed in three rows, three bottles per row, which are separated from each other by 8 rows; in each row, the bottles are separated from each other by 8 coconut palms. The second set of 3 compounds x 3 bottles was installed a few days later in the same design.

No *S. sunidesalis* were captured. However, two crickets, two weevils, a fly and a spider were caught, which proves a certain degree of substance diffusion. Examination of the capsules revealed the existence of a whitish deposit on the outer wall of some of them. We thus attributed a subjective score to determine the effect of probable sweating of the substance on the rubber.

Figure 9 : Model of traps for catching *S. Sunidesalis*



This trap consists of a plastic bottle (e.g. mineral water bottle) in which 2 x 4 slits measuring approximately 2.5 x 1 cm are made (along the grooves).

The pheromone diffusing capsule is hung inside the bottle level with the slits. The capsule is protected from sunlight by a cardboard shade.

Attracted insects land on the bottle and climb towards the slits (scratches made with a knife or scalpel provide a good grip for the claws of their tarsi), gaining access very easily, and drown in the water + wetting agent mixture (teepol), which can be replaced by an insecticide strip.

The geometry of this trap was inspired by studies of male landing behaviour; in the wild they land much more often on vertical supports than horizontal.

- With the large bottles: compounds

A	B	C
+++	-	-
+++	-	+
+++	-	+

- With the small bottles: compounds

A	B	C
-	++	-
+	-	-
+	+	-

The trapping trials will have to be continued with other attractants, but that will require further electroantennography tests on other adults.

X. PROTECTION AGAINST *Sufetula* AND INCREASING MOISTURE IN THE SURFACE HORIZON OF THE SOIL AT THE FOOT OF COCONUT PALMS - HSF 14 = RS-ES 73 and HSF 15

X. 1. Purpose

Given the latest observation results for attacks by the caterpillar of this insect, it seems necessary to ensure protection against both the aggression of the pest and against erosion at the foot of the coconut palms, which uncovers the superficial roots that are primarily absorbent roots. The soil cover around each coconut palm will serve both to increase the amount of moisture in the first 30 cm of soil, and down to a depth of 80 cm below the stem, and to limit *Sufetula* attacks.

X. 2. Method

Each elementary plot comprises 5 rows of 5 coconut palms each. There are three replicates for each experimental treatment.

For the soil cover within a 2-m radius around the foot of each coconut palm, the following can be used:

❒ coconut husks left in the plantation after dehusking of collected nuts (HSF 14 / A07-01)

❒ "cocopeat", residues from coconut husk fibre removal (HSF 14 / A07-01)

❒ dry fronds, without the widened base of the rachis, and empty bunches (HSF 15 / A07-02)

Monthly insecticide treatments are also planned; the following formulations will be alternated:

❒ Dursban 30 ml / 6 litres of water

❒ Lannate 12 ml / 6 litres of water

❒ Supracide 20 ml / 6 litres of water

1 ml of sticker will be added per litre of water (Agristick, Industick or other).

Figures 10 and 11 give details of the experimental design that was set up during the mission. The trials with coconut husks and cocopeat are being conducted in the south of plot A07-01 and the trial with fronds and empty bunches in the south of A07-02; these two plots are widely attacked by the pest.

The usual fertilizer rates will be applied on the soil or directly on the cocopeat, and on the husk, in a ring 1 m from the stem.

X. 3. Observations

Root samples are taken every three months 1 m from the stem and in two holes with the following dimensions: 1.00 m x 40 cm x 40 cm, 1 hole in the planting row. The first sample was taken before the husk and cocopeat were laid, and before the treatments.

An initial nut count, from leaf 10 to the lowest leaf, was carried out on the central 9 palms of each elementary plot when the trial was set up. Subsequent counts will be made every three months on the same central 9 palms in all the elementary plots.

X. 4. Results

Root samples were taken during the mission, which showed us that tertiary roots have developed well under the layer of cocopeat, but this treatment does not ensure total protection against *S. sunidesalis* attacks, especially on primary roots. It is very curious that the additional monthly treatments do not improve protection at all. The application of cocopeat was also found to have several disadvantages: it was very easily carried away by violent rainwater runoff from the base of the palms or dried bunch spathes, and the roots are uncovered again; some layers of cocopeat reveal zones of mould development that vary in extent. The mouldy zones should be monitored to see whether they spread, and whether or not the fungi are pathogenic. We had more cocopeat placed around the foot of the coconut palms in a 30 to 40 cm high mound, over a distance of about 1 m around the stem; the root sampling holes were also filled in (Table 10).

Under the layers of coconut husks, the tertiary roots also developed well, but protection was no better than with cocopeat: on the primary roots, the effect is very heterogeneous, and apparently very good according to samples taken in September 98. However, the effect is not particularly marked on secondary and tertiary roots. In this case too, the additional insecticide treatments on coconut husks do not improve protection (Table 10).

Dried fronds provide slight protection from *S. sunidesalis*. They also rapidly form a layer of humus on top of the soil (Table 12).

On the whole, in this trial the Dursban or Supracide treatments, either alone or combined with cocopeat and coconut husks, do not give encouraging results, which is quite surprising (Tables 10 & 12).

It seems clear that there can be no substantial effect of the protection against *S. sunidesalis* and against erosion on yields only 9 months after the trial was set up (Tables 11 & 13).

Comments: Under these conditions, there is no need to continue with the additional insecticide treatments on cocopeat and coconut husks. The "treatments only" palms will eventually become a second control. This trial should be maintained for a further 2 years to ascertain whether such root protection with coconut husks and cocopeat has any beneficial effect on yields.

Figure 10 : A 07- 01 - HSF 14 - RSUP - Protection against S. sunidesalis and improvement of the humidity of the soil superficial horizon by the coconut foot

C Control

H 2 layers of coconut husk on 2 m radius around the stem

HI 2 layers of coconut husk + insecticide treatment every month on 2 m radius around the stem

CP 1 layer of 10 cm cocopeat on 2 m radius around the stem

CPI 2 layers of cocopeat + insecticide treatment every month on 2 m radius around the stem

I Only insecticide treatment every month on 2 m radius around the stem

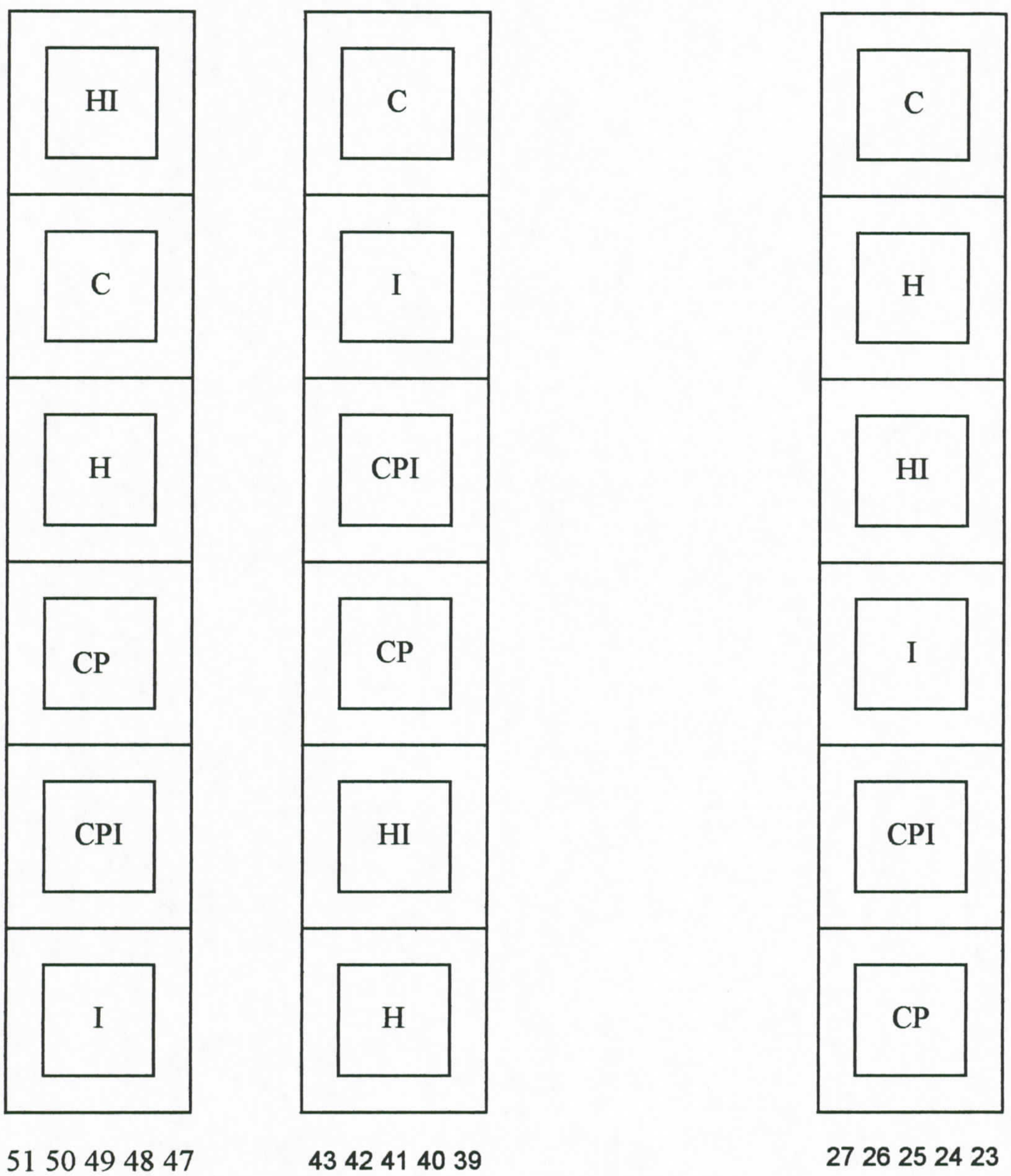


Figure 11 : A 07- 02 - HSF 15 - RSUP - Protection against S. sunidesalis and improvement of the humidity of the soil superficial horizon by the coconut foot

C Control

F 2 layers of dry fronds and bunch stalks on 2 m radius around the stem

FI 2 layers of dry fronds and bunch stalks + insecticide treatment every month on 2 m radius around the stem

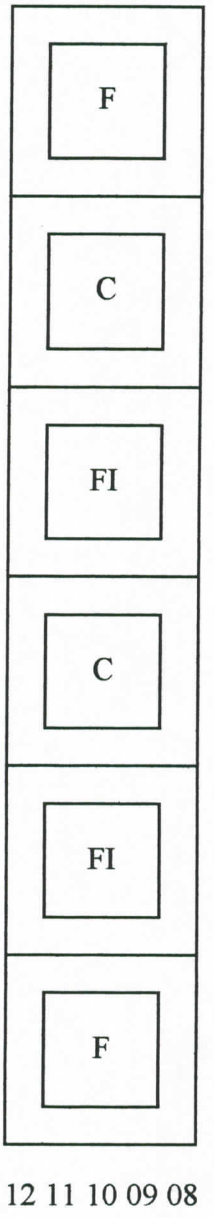


Table 10: HSF 14 / A07-01 = RS-ES 73- Variation in *S. sunidesalis* attacks on roots after covering the soil around the coconut palms

Treatments / Dates	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
Cocopeat				
December 97	11.5	3.1	11.2	9.2
March 98	16.7	1.5	0.8	1.5
June 98	13.8	6.2	1.2	2.1
September 98	47.7	9.2	10.8	11.7
Cocopeat +Treatments				
December 97	28.9	18.5	22.3	22.4
March 98	28.3	17.9	0.4	3.1
June 98	4.9	4.5	0.5	1.1
September 98	33.3	9.7	6.9	8.4
Treatments only				
December 97	18.7	27.9	5	7
March 98	27.2	18.5	7.3	9.4
June 98	20.4	16	4.1	6.2
September 98	35.7	7.5	0.3	1.2
Coconut husks				
December 97	60	12.5	4.7	8.2
March 98	6.7	3.6	1.6	1.9
June 98	50	11.8	2.1	2.8
September 98	0	20.7	8.8	9.2
Coconut husks + Treatments				
December 97	32	18.8	8	9,7
March 98	16.1	40.2	11.5	14.9
June 98	36.8	6.6	1.7	3.5
September 98	76.9	28.1	3.2	5.2
Control				
December 97	25.5	14.8	4.9	6.8
March 98	52.2	3.1	0.8	2.5
June 98	37.9	26.1	3.2	7,4
September 98	52.5	23.1	13	18,6

Table 11: HSF 14 / A07-01 - RS-ES 73 -Effect on coconut yields of protecting from *S. sunidesalis* by covering the soil around the coconut palms and of treatments

Treatments	Dates	Number of palms	Average number of nuts at			
			L10	L14	L15 to L28	L11 to L28
Cocopeat	December 97	18	6.7	1.8	42.5	53.9
	June 98	18	9.6	3.2	22.9	38
Cocopeat +Treatments	December 97	15	2.5	1.7	20.2	26.2
	June 98	15	6.4	1.8	15.7	24.9
Treatments only	December 97	16	10.7	4.4	47.7	69
	June 98	16	9.9	3.9	47.5	67.9
Coconut husks	December 97	12	4.4	2.3	32.5	40
	June 98	12	6.9	1.9	22	34
Coconut husks +treatments	December 97	15	7.1	3.6	48.2	61.2
	June 98	15	10.8	3.4	36.4	58.2
Control	December 97	14	7.7	3.4	41.4	56.4
	June 98	14	8.2	2.1	33.3	46.9

Table 12: HSF 15 / A07-02 - Variation in *S. sunidesalis* attacks on roots after covering the soil around the coconut palms

Treatments / Dates	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
Dry leaves only				
November 97	46.1	8.3	7	6.1
March 98	16.7	4.5	1	1.8
June 98	16.7	5.6	0	2
September 98	26.7	22.2	2.4	4.6
Dry leaves +Treatments				
November 97	0	4.8	5.1	4
March 98	7.7	0	0.3	0.6
June 98	0	5.4	1.7	2.7
September 98	44.8	19	1.6	4.7
Control				
November 97	0	12.1	4	4.1
March 98	25	0	0	1
June 98	9.5	11.6	1.2	5,6
September 98	33.3	35.2	2.2	6,9

Table 13 : HSF 15 / A0-02 - RS-ES 73 -Effect on coconut yields of protecting from *S. sunidesalis* by covering the soil around the coconut palms, and of treatments

Treatments	Dates	Number of palms	Average number of nuts at			
			L10	L14	L15 to L28	L11 to L28
Dry leaves only	November 97	18	15.2	4.7	43.7	71.2
	June 98	12	14.9	2.9	41.3	65.7
Dry leaves + Treatments	November 97	18	12.3	3.9	55.9	74.1
	June 98	12	9.8	4.6	40.7	65.8
Control	November 97	18	9.1	3.5	39.8	55.6
	June 98	12	6.5	2.4	32.3	46.2

XI. MISCELLANEOUS OBSERVATIONS

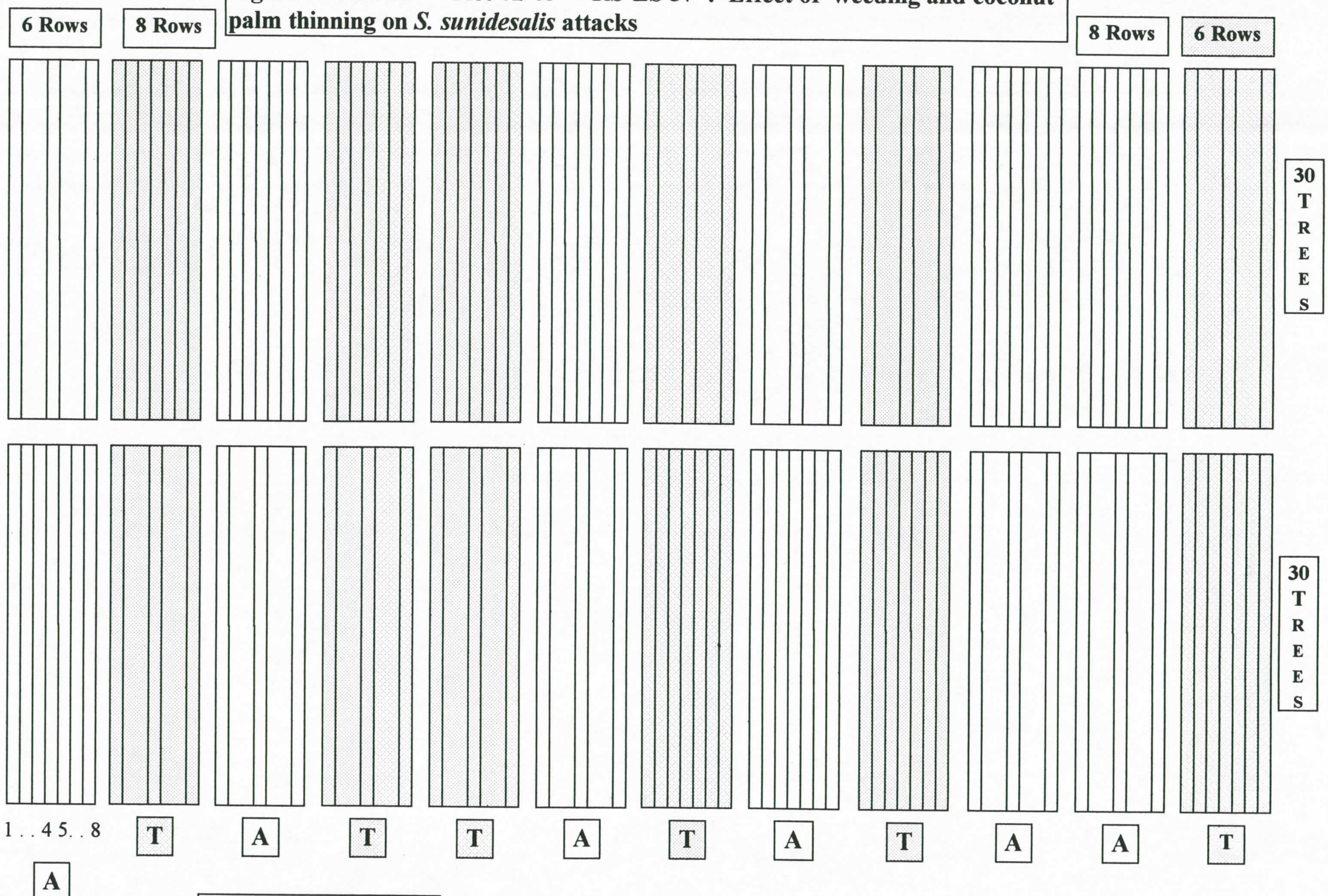
XI.1. RS-ES 57 / Plot 02-03 - Effect of weeding and coconut palm thinning on *S. sunidesalis* attacks.

The purpose of this agronomy trial, set up on March-April 1997, is to test the depressive effect of planting density, which would seem to be too high at Pulau Burung (180 palms/ha). This would then explain the canal edge effect, since those palms receive more light than the inner palms. A row of coconut palms has thus been removed and production trends on the remaining two rows are being monitored in relation to a non-thinned control. In addition, the study of the thinning effect is combined with a study of the soil cover effect. The elementary plots comprise 8 rows of 30 palms each; rows 3 and 6 of each elementary plot of "thinning" treatment have been felled.

Root samples were taken from 4 coconut palms (Figure 12) in the central 2 rows of each elementary plot in the three blocks located to the west of plot 02-03; the 4 palms were chosen at random using a small random draw program developed by François Bonnot, a CIRAD-CP biometrician.

Table 14 shows that, for the moment, there is no substantial difference in the level of new caterpillar attacks between the treatments in the trial. It is therefore still impossible to say how effective weeding is on *S. sunidesalis* attacks in this plot, contrary to trial RS-ES 21 conducted in the plot. It needs to be pointed out that the trial is being conducted on palms around 10 years old, and attacks on the roots of those palms are known to be considerable, or even total in most cases. It is therefore very difficult to detect any differences in the level of attacks on new roots, which are generally few in number, especially in the case of primary and secondary roots. In addition, we feel that the elementary plots are still not large enough to prevent re-infestation from the unweeded plots.

Figure 12 : RSUP - Plot 02-03 - RS-ES 57 : Effect of weeding and coconut palm thinning on *S. sunidesalis* attacks



A = Bare soil
T = Soil with ferns

Table 14: RS-ES 57 / Plot 02-03 - Effect of weeding and coconut palm thinning on *S. sunidesalis* root attacks

Weeding (A)	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
% old attacks	803	711	539	593
% new attacks	162	148	32	51
Weeding + felling of 2 rows (A1)	**Primary**	**Secondary**	**Tertiary**	**Mean**
% old attacks	797	666	476	516
% new attacks	204	136	24	37
Fern cover (C)	**Primary**	**Secondary**	**Tertiary**	**Mean**
% old attacks	86	846	51	569
% new attacks	194	236	28	4
Fern cover + felling of 2 rows	**Primary**	**Secondary**	**Tertiary**	**Mean**
% old attacks	868	74	53	592
% new attacks	21	104	3	42

XI.2 TRIAL RS-CC 07 - RSTM

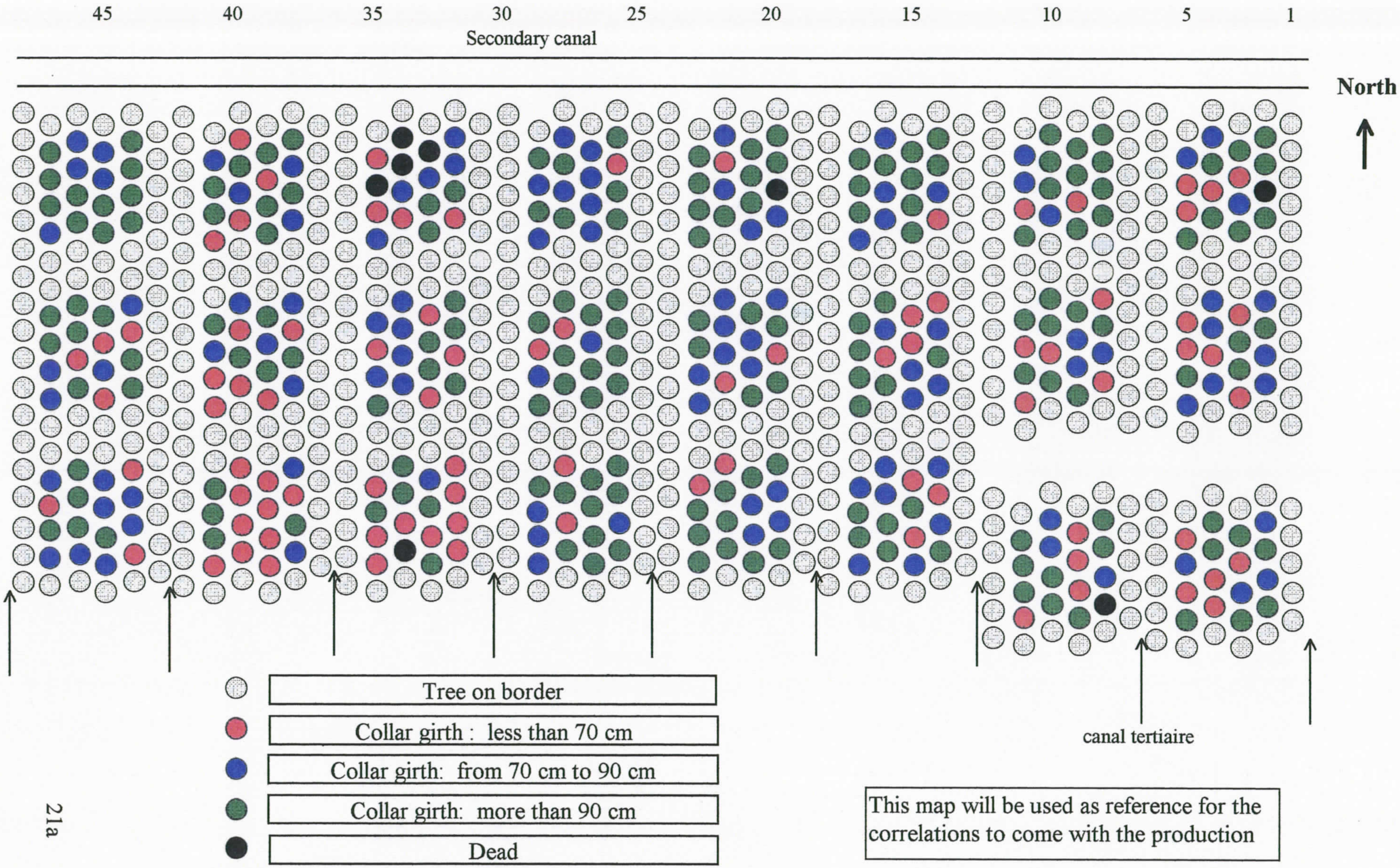
Remember that the purpose of this trial is to study the effect of silica and chemical protection against *S. sunidesalis* on the growth of young hybrid coconut palms on deep peat.

Girth measurements are taken every three months. Figure 13 shows the distribution of girth values for the set of measurements taken at the end of August 1998. It can be seen that there is still heterogeneity in palm growth following a rise in the water table that probably occurred in the first six months. This has explained the presence of small palms that are sometimes surrounded by tall palms or medium sized palms. This distribution of palm growth can be considered in relation to the yields mapped in plots A07-01 and A07-02 (see mission report CP SIC 846/September 1997).

These observations clearly indicate that heterogeneity in coconut palm height results from considerable agronomic stress when the palms were young. Such heterogeneity is already going to affect the production of the coconut palms in question, since there is a positive correlation between coconut palm height and yields.

By the 15th month, it was seen that although *S. sunidesalis* attacks had increased in the untreated zones of the trial, they remained quite slight throughout the root system. The percentages of attacked roots are given in the report by X. Bonneau (Doc CP n° 98 - October 98). The low level of *S. sunidesalis* attacks is due to the fact that the coconut palms in this trial were planted on completely bare soil.

Figure 13 : RSTM - RS-CC 07 - Effect of Silica and protection against *S. sunidesalis* on the growth of young hybrid coconut palms on deep peat.



For the time being, this pest has no effect on coconut palm growth in this trial, which in our view serves as a reference: future data on the start of bearing and production itself, i.e. the nut load on the palms, and on *S. sunidesalis* attacks, will undoubtedly provide us with precise information regarding the degree of impact attacks by this insect have on yields.

XI.3. TOUR OF TWO YOUNG COCONUT PLOTS AT RSTM

The soil in plot 36-11 (May 1997) has not been compacted in the planting rows. **Weed cover is maximum**. There was very severe coconut palm mortality. Samples were therefore taken from the first 5 border palms. Their root system was poorly developed: very limited root mat severely attacked by *S. sunidesalis*, though they are only 15-month-old coconut palms (Table 15).

The soil in plot 37-11 (June 1997) was compacted in the planting rows. In addition, **weed cover is particularly substantial in the interrows**. The mortality rates is very low, but there is considerable heterogeneity in the palm heights. Nevertheless, their roots systems are severely attacked by *S. sunidesalis*. These are also 15-month-old palms (Table 15).

Thus, the tour of these two plots enabled us to emphasize that an abundant plant cover (in this case ferns) helps the proliferation and maintenance of a large *S. sunidesalis* population.

Comment: If trial RS-CC 07 is considered in relation to plots 36-11 and 37-11, all three plots having the same age, it can be concluded that total and perfect weeding prior to planting is important; these attacks could increase very rapidly as time goes by, with the development of the plant cover.

Table 15: Level of *S. sunidesalis* attacks in two 15-month-old plots at RSTM

Plot 36-11 (May 1997)/RSTM	% new attacks on roots			Mean
	Primary	Secondary	Tertiary	
% old attacks	62.04	51.29	44.32	46
% new attacks	51,22	28,32	6,97	11
Plot 37-11 (June 1997)/RSTM	Primary	Secondary	Tertiary	Mean
% old attacks	70,37	68,42	55,06	58.8
% new attacks	37,5	16,67	8,75	12

XI.4. LEVEL OF *S. sunidesalis* ATTACKS IN TRIAL RS-ES 21 / RSUP

Remember that the purpose of this trial is to study effect of the soil cover on the growth of coconut palms planted on peat.

An analysis of *S. sunidesalis* attacks on the roots systems of palms in this trial was carried out in May 1998 by the Pests and Diseases division of the Plantation. Recent *S. sunidesalis* attacks were noted in two unit volumes of 100 x 40 x 40 cm, taken 1 m from the stem of each sampled coconut palm, one in the planting row, one in the interrow. Three coconut palms were taken at random in each elementary plot out of 20 useful palms.

Table 16 shows very slight differences between treatments 1 and 2, 1 and 3, 1 and 4, 1 and 5. However, some very clear differences appear in the level of root attacks between the "natural regrowth" (1) and "bare soil" (6) treatments. **Thus, the coconut palms with natural regrowth as the plant cover have primary roots that are twice as severely attacked as those on bare soil. The secondary roots of the coconut palms with natural regrowth as the plant cover are only slightly more attacked than those with bare soil. However, on the tertiary roots, there is no notable difference between treatments 1 and 6. Moreover, the mean percentage of *S. sunidesalis* attacks for all the roots combined is not fundamentally different from one treatment to the next.** This result is due to the fact that the new primary roots encountered in the volume of soil sampled are much less numerous than the secondary roots, and especially the tertiary roots. Calculation of the attack percentage on new roots is therefore a little distorted.

The presence of a not insubstantial percentage of attacked roots in the "bare soil" section results from the fact that the elementary plots are too small (4 rows of 12 coconut palms each). Re-infestation by *S. sunidesalis* adults is very easy from the weedy plots located next to the "bare soil" plots.

Table 17 shows that the nut load in the coconut palms recorded in September 98 is not significantly different from one treatment to another. Coconut palm height is fairly uniform from one treatment to the next. However, this nut load may be slightly different from the yields actually harvested.

Nut yields have been recorded in this plot since the palms started bearing. It can be seen that in the very weedy section the coconut palms have always produced less than those in the "bare soil" section. In 1997, the difference in yields between these two sections was highly significant at the 5% level from 1995 onwards, i.e. 7 years after the trial was set up (Table 18).

Table 16: Level of *S. sunidesalis* attacks in Plot 06-07 (January 1988) / RSUP - RS-ES 21

Plots	Position of hole	Primary roots		Secondary roots		Tertiary roots		Mean
		Attacked	Healthy	Attacked	Healthy	Attacked	Healthy	
1	In interrow	3.42	2	2.58	4.33	12.5	42.58	
	In planting row	4.33	6.5	4.67	9.08	10.33	60	
	Total	7.75	8.5	7.25	13.41	22.83	102.58	162.32
	%attacks	47.7		35.90		18.20		23.31
2	In interrow	1.08	1.58	2.67	4.83	11.75	41.25	
	In planting row	2.42	7.92	2.58	4.75	7.42	48.67	
	Total	3.5	9.5	5.25	9.58	19.17	89.92	136.92
	% attacks	26.92		35.40		17.57		20.39
3	In interrow	5.5	5.5	2.92	5.17	22.33	94.42	
	In planting row	3.08	7.25	3.5	10.33	18.08	74.42	
	Total	8.58	12.75	6.42	15.5	40.41	168.84	252.5
	% attacks	40.23		29.29		19.31		21.94
4	In interrow	2.92	3.42	1.5	4.58	16.17	43.67	
	In planting row	5.67	3.83	3.67	5	17.17	72.58	
	Total	8.59	7.25	5.17	9.58	33.34	116.25	180.18
	% attacks	54.23		35.05		22.29		26.14
5	In interrow	1.33	3.58	1.92	3.5	10.17	33.17	
	In planting row	1.92	6.83	0.83	5.58	30.67	64.5	
	Total	3.25	10.41	2.75	9.08	40.84	97.67	164
	% attacks	23.79		23.25		29.49		28.56
6	In interrow	0.92	2.67	2.42	5.67	8.83	51.75	
	In planting row	1.58	6.5	2.42	7.67	11.75	44.5	
	Total	2.5	9.17	4.84	13.34	20.58	96.25	146.68
	% attacks	21.42		26.62		17.62		19.03

Key:
1 = natural regrowth: all the cover plants are kept.
2 = only the Nephrolepsis sp fern is kept.
3 = only the Atrium sp fern is kept.
4 = only the Blechnum sp fern is kept.
5 = only plants other than Nephrolepsis sp, Atrium sp and Blechnum sp ferns are kept.
6 = bare soil control: all the cover plants are eliminated.

Table 17: Nut load and coconut palm heights in Plot 06-07 (January 1988) / RSUP - RS-ES 21 / September 98

Treatment	Average number of flowers or nuts at (12 palms/treatment)					Height
	L10	L11 to 13	L14	L15 to 28	L11 to 28	Mean
1	188	273	9	226	508	6
2	148	173	9	185	367	61
3	157	183	14	135	333	59
4	155	190	3	248	442	6
5	159	184	17	249	450	63
6	248	316	12	330	658	66

Table 18: Annual coconut yields in Plot 06-07 (January 1988) / RSUP - RS-ES 21

Treatment	AVERAGE NUMBER OF COCONUTS PER PALM						
	1991	1992	1993	1994	1995	1996	1997
1	8	308	423	503	582	690	626
2	14	368	446	581	634	700	740
3	13	541	581	533	630	790	756
4	12	382	466	556	593	658	650
5	16	502	588	611	622	743	817
6	14	565	676	631	825	820	982

CONCLUSIONS

Monitoring of *S. sunidesalis* populations in 4 plots at the RSUP plantation reveals that there were more attacks in 1998 than in the previous year.

Rearing this insect on artificial medium or in sleeves over young coconut palms is proving very difficult.

Light trapping with UV tubes did not lead to many *S. sunidesalis* captures. The first tests of three attractants have not given positive results. Furthermore, it has not been possible to detect any pheromone in *S. sunidesalis* females. Trapping trials will be continued with other attractants.

The two contact insecticides tested, Dursban and Supracide, provide satisfactory protection of the root system, but it is short-lived: 1 to 2 weeks at the most, depending on the amount of rainfall. It will therefore be necessary to test a weekly treatment on around twenty coconut palms, for find out whether it is possible experimentally to obtain a perfectly healthy root system. It will then be possible to assess how yields are affected by effective restoration of the root system on coconut palms attacked by *S. sunidesalis*.

After a year, monthly insecticide treatments have yet to bring about any improvement in coconut yields. Remember that floral induction occurs two years before the inflorescences appear. Consequently, it takes at least three years to reliably assess the effect of this improvement.

Cocopeat and coconut husks do not ensure a complete protection of the roots against *S. sunidesalis* attacks. However, they offer the advantage of maintaining satisfactory humidity in the upper layer of soil (20 to 40 cm), which was found to be very dry during the last mission.

It clearly appears that weeding effectively reduces *S. sunidesalis* attacks on coconut palm roots, especially the primaries.

RECOMMENDATIONS

HSF 05 / A06-03

- Halt this trial, because it is difficult to obtain any effect on yields since there are only 10 coconut palms protected by black plastic sheets; the sheets rapidly tear and re-infestation by *S. sunidesalis* is then very easy.

HSF 09 / A06-03

- Halt this trial, because sufficient data have been acquired on the emergence of *S. sunidesalis* adults.

HSF10 / A07-01

- Testing of different insecticides - The following modifications have been made:
SU_2 20 ml of Supracide / 6 litres of water /palm every month
SU 20 ml of Supracide / 3 litres of water /palm every month
C Control
Continue this trial for at least another year with the new protocol.

HSF11 / A07-02

- The following modifications have been made:
Replace D1 and D2 with a single dose of Dursban and a single volume of water: D1 + D2 = D (Dursban) = 30 ml / 3 litres of water / palm every month.

HSF14 / A07-01 = RS-ES 74

- Halt the treatments in the HI, CPI and I elementary plots.
- Renew the cocopeat if necessary, especially after root sampling every three months. Check that the cocopeat has not been carried off by water runoff after heavy rain. More should be added if necessary.
- Add coconut husks if there are holes in the original layer of husks, and especially after root sampling.
- Check the condition of the layers every month.

HSF15 / A07-02

- Halt treatments in the FI elementary plots.

For these two trials HSF 14 and HSF 15, root samples should be taken in each elementary plot from 2 border palms and 9 central palms.

***S. sunidesalis* rearing**

- Try again to rear this insect on coconut seedlings in polybags, releasing around a hundred adults into each sleeve. The plants should be placed in the laboratory handling room. Check whether any new adult generations emerge in the sleeves.
- Try to maintain a strain of *S. sunidesalis* in large Petri dishes.