

INVENTORY OF HOMOPTERA AND HETEROPTERA IN RELATION TO THE AMARELECIMENTO FATAL DISEASE

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1. Introduction

With respect to amarelecimento fatal in the oil palm research has been carried out on several different aspects, such as the study of the roots, the influence of the soil, the search for fungi, vector insects and so forth. Epidemiological studies rapidly demonstrated that the disease is transmitted through the air and is not dependent on the nature of the soil.

However, up to the present time isolation and observation using an electronic microscope have failed to reveal the presence of any pathogen, such as fungi, bacteria, protozoans or nematodes. Consequently, there is a strong case for the hypothesis of transmission of a pathogen of the virus or viroid type. In this case transmission would certainly involve a vector insect. Since mechanical transmission has yet to be achieved, *Homoptera* and *Heteroptera* are considered as the most suspicious vectors. An inventory of these two types of insects is now being carried out at Denpasar, with the support of that company and APRODEN, which, based on an EMBRAPA/CIRAD research agreement, involves technical personnel from IRHO.

2. Gathering methods

2.1. Gathering in vials

2.1.1. Methodology

The insects found on the oil palm are gathered directly into vials. Every month there is a systematic process of gathering these insects from a specific number of pre-determined oil palm trees. In this way it has been possible to monitor these insects on a month-by-month basis.

2.1.2. Inconveniences

These observations are made at specific time intervals and include only trees whose leaves can be examined without the aid of a ladder, thus somewhat restricting the number of observation sites.

2.1.3. Location of the tests

Different types of tests are carried out:

- By site: At each site the gathering process is carried out on two trees separated by other trees. This was begun in June 1987. Total: 32 oil palm trees.
- By block: The insects are gathered

from blocks of 20 trees forming one group. This operation began in January 1988. Total: 80 oil palm trees.

- Area coverage: The insects are collected from isolated evenly spread trees, so as to cover the entire area. The operation began in February 1988. Total: 93 oil palm trees.
- Overall total: Every month the insects are gathered from a total of 205 oil palm trees.

2.2. Yellow trap

2.2.1. The trap

The trap is made of two squares of wood measuring 20cm x 30cm. A sheet of plastic of the same size is stretched over each square. With the use of string, these two squares are then placed around leaf no. 1, one on the internal surface and the other on the external surface of the leaf. The traps are changed every two weeks.

2.2.2. Inconveniences

This system makes permanent gathering possible, but not all insects are attracted by the color yellow, particularly those that are active during the night.

2.2.3. Location

- By site: Each one of the aforementioned sites has one yellow trap, with the exception of the sites in areas D2d and E2d. Total: 12 traps.
- By disease containment tests: Different disease containment tests have been installed independently of the inventory tests. Two yellow traps were installed for each one of these tests, for the purpose of observing the effects of the *Homoptera* of the

oil palm on the fauna (see appendix 1). Total: 14 traps.

Appendix 1. Number of areas with yellow traps, in relation to the disease containment tests.

Tests	Test area	Witness
Diseased area	F2a	DO 1d
Monocrotophos	F1b	FOd
Endosulphan	F2C	F3a
Bare soil	E4B	--

- Division II: The study of the *Homoptera* fauna present in this division was deemed interesting since it had suffered very little impact from the disease. Three areas were chosen and two traps were assembled in each one of them. Total: 6 traps. Overall total: 32 yellow traps.

2.3. Sheet

2.3.1. Methodology

Two sheets measuring 2m x 3m were stretched under an oil palm treated with monocrotophos (root injection + trunk injection). The dead insects fall on the sheets and are collected twice a week.

2.3.2. Inconveniences

This method functions very well for heavier insects (*Coleoptera*, caterpillars) but very few *Homoptera* can be gathered through the use of this method. The dead insects either fall on the axils of the leaves and thus do not reach the ground or are blown by the wind and fall outside the sheets. At the same time, it is possible that the monocrotophos has a repellent effect and, should this be true, the insects no longer visit the treated trees. Since results were sparse, this method was abandoned.

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2.4. Gathering with an entomological net

2.4.1. Methodology

Gathering is done with an entomological net that is 35cm in diameter. It is done in the areas between the trees and the net is passed about ten times between each pair of oil palms (9 meters). The net therefore is passed about 100 times over a distance of approximately 90 meters. The insects gathered are placed in a hand cage and the material is then studied in the laboratory. This type of gathering is done every month at each site mentioned above. Thus there is a total of 16 gathering operations.

2.4.2. Inconveniences

In this operation, many insects that have no relationship to the oil palm are captured, including the *Cicadellidae*. Certain types of insects that are very common but protect themselves within the leaves of the plant are captured in only small quantities, such as the *Delphacidae*.

2.5. Emergency cage

2.5.1. Methodology

A certain number of insects produce larvae that live in the roots of different types of plants. These cages cover a ground area measuring 1m x 1m and make it possible to gather such insects as soon as they emerge from the ground and, thus, define the entomofauna related to the ground coverage. The cage is placed on a ground coverage as homogeneous as possible (normally grasses), and the insects that enter the cages are collected two times a week. The cage remains in

place for a period of 5 to 6 weeks.

2.5.2. Inconveniences

The species collected in this way are generally related to the type of ground coverage, though some of them do spend their adulthood in the oil palm. This method provides no information on the insects that are totally dependent on the oil palm. The tests with these cages were interrupted in September 1987.

3. General inventory

The inventory that was carried out using these different methods lasted until the middle of February 1988 and produced 187 species of *Homoptera* and 55 species of *Heteroptera*. The division of these insects by family is shown in appendix 2.

4. Gathering in vials

4.1. Gathering by place

The accumulated collection operations are shown in appendix 3. Very few *Cicadellidae* were gathered directly from the oil palm. Most of the insects (96%) were *Derbidae* and four dominant species (D1, D3, D3b and D50) were found in all of the gathering operations. Other species, such as the D5, were very abundant in the area of clones.

Note should be taken of the presence and irregular distribution of D2 (*Mynodus crudus*) at Agropar and its absence in the clone area. *Hemiptera* type insects were not commonly found on the oil palm at Denpasar.

Appendix 2. General inventory at Denpasar: Number of species gathered.

Family	Total	Vials	Gathered on oil palm	
			Yellow traps	Total
HOMOPTERA				
<i>Cicadellidae</i>	95	8	74	74
<i>Cercopidae</i>	2	0	0	0
<i>Membracidae</i>	22	9	16	18
<i>Fulgoridae</i>	1	1	0	1
<i>Derbidae</i>	31	20	12	23
<i>Delphacidae</i>	15	1	4	4
<i>Dictyopharidae</i>	2	1	1	1
<i>Cixiidae</i>	3	2	3	3
<i>Nogodinidae</i>	1	0	0	0
<i>Flatidae</i>	3	1	1	1
<i>Issidae</i>	1	0	0	0
<i>Psyllidae</i>	1	0	0	0
<i>Aleyrodidae</i>	6	0	2	2
<i>Aphidae</i>	2	0	0	0
<i>Others</i>	2	0	0	0
Total	187	43	113	127

4.2. Gathering by block (see appendix 4)

This operation lasted for only two months. Despite the fact that repetitions were few, the same results as in the previous test were found. Though not very frequent, it should be noted that the *Flatidae* D14 was found to exist in several localities, normally in the form of larvae.

4.3. Gathering in area coverage

This was begun in February and, since only one gathering operation has been completed, data are still insufficient.

5. Yellow traps with "stick"

The only older traps (6 to 8 months) are those distributed by site at Agropar and a series placed at Denpasar where the disease was quite common, coupled with another in a healthy area. The other traps were installed in

January and have not yet produced results.

5.1. Agropar

The accumulated results are shown in appendix 5. As always, the dominant family is the *Derbidae* with three species (D3a, D3b and D50) found in practically all of the localities. Despite the fact that they are uniformly distributed (as shown by the vial collections), the D1 species does not seem to be strongly attracted to yellow. For this reason, few of these insects were gathered. A large variety of *Cicadellidae* is captured in this way and some species, such as D65, appear in large quantities. Among the *Cixiidae*, D2 is sometimes found in large numbers (site 3) and sometimes appears to be absent. However, it is already known that this insect is often strongly concentrated in a single locality. The presence of *Flatidae* D14 in some sites should be noted. Few *Hemiptera* are gathered in this manner.

ground coverage. *Derbidae* species are not very numerous.

Very few *Cixiidae* D2 were gathered in the entomological net, just as few *Flatidae* were found.

7. Emergency cage

Only grass-type plants were tested and these belonged basically to three species: *Homolepis aturensis*, *Paspalum conjugatum* and *Paspalum maritimum*.

Appendix 5. Gathering with yellow traps; AGROPAR.

Family	Ref.	Site	1	2	3	4	5	6	7	8	9	10	TOTAL
<i>Cicadellidae</i>	D6		2	1	1	12	1	6	1	8	2	1	35
	D9		1	5		8	2		1	1	4		22
	D37		1	4	2	1		1		2			11
	D47				1	2			18	4	11	2	38
	D53		4	2	3	3	4	5	17	9	2		49
	D65		3	1	3	2	4	1	8	4	36	55	117
	D93		25	10	6	4	2	9	3	10	7	3	79
	D94		5	10	6	7	1	1	1	14			46
	D103		7	4		2	5	10	3	6	7	11	55
	D105			3	1	2	2	8	4	30	6	8	64
	D112		5	5			2	4		1		2	19
	D113		18	1	1					1	2	1	24
	D127		5			3			2				10
	D168		1		2	1	2	2	4	4	2	4	22
	Others		85	25	21	21	8	11	15	48	17	34	
<i>Membracidae</i>	D16			1	5	1	1	3	2		3		16
	D18					1				2	2	1	6
	D68			2	3	3	2	5		1	1		17
	D104			1		1	3	2		1	1		9
	Others		2	1	4	1		4	1	1	16	2	32
<i>Derbidae</i>	D1		3		3	1	2	3	1	7	3	2	25
	D3a		2	54	76	128	12	36	89	29	52	8	486
	D3b		2	147	97	108	17	20	69	22	92	22	596
	D4			1	1								2
	D5							1					1
	D27		4	2	6			3	2		124	9	150
	D50			135	90	97	2	2	127	2	20	1	476
	Others		3		1		1			1			6
<i>Cixiidae</i>	D2			4	83	2	3	2		9	12	25	140
	D46		4					1	3	1	1		10
<i>Flatidae</i>	D14		2		1	1			1				5
Others			1		2	3	2	4	3		2	3	20
<i>Miridae</i>	D30P			2									2
<i>Coreidae</i>	D1P				1								1
<i>Corizidae</i>	D54P									1			1
<i>Cydnidae</i>	D38P												1
											1		1

In all cases, the *Cixiidae Myndus crudus* (D2) was found in association with these plants, though *H. aturensis* and *P. maritimum* seem to have a greater proliferation of this species.

On the other hand, only *Derbidae* D3b was found in lesser quantities on *H. aturensis* and *P. maritimum*. Evidently, this species is common to one or various host plants. The other common *Derbidae* (D1, D5) seem to have different host plants, perhaps the oil palm itself.

Many *Delphacidae* were found on *H. aturensis* (D12) and on *P. maritimum* (D31). The latter *Delphacidae* seems similar to the *Sogatella*, which is known as a vector of dry bud rot in Africa.

8. Suspect species

Two species have been suspect since the beginning: *Derbidae* D1 and *Cixiidae* D2. Later, the study of the entomofauna showed that there are other suspect species:

- based on their great abundance: *Derbidae* D3a, D3b, D50, *Delphacidae* D31;
- based on their distribution in infected areas: *Derbidae* D27, *Cixiidae* D46;
- based on the significant number found in the yellow traps: *Cicadellidae* D65, D93, D105.

On the other hand, for purpose of comparing the entomofauna of other regions of Brazil, visits were made to both healthy areas: EMADE (Tefé-AM), CRAI (Moju-PA), AGROMENDES (Acará-PA) and ERRU (Rio Preto da Eva-AM); and diseased locations: SOCFINCO (Alvarães-AM) and CODEPA (Porto Grande-AP). The gathering operation was based on both vials and entomological nets, so that the insects collected could be compa-

red to those found at Denpasar (see appendix 8).

This led to the suspicion that *Flatidae* D14 could be involved, since it seemed to be closely related to the small diseased areas found at CODEPA.

Appendix 7. Gathering by site with entomological net.

Family	Agropar 1983													Clone area 1985	Crossing test, replanting 1987				TOTAL GENE- RAL		
	Site 1			Site 2			Site 3			Site 4			TOTAL		P45 A50 P70		P70 TOTAL				
Ref.	N100	N50	A80	P40	P40	P50	A50	P90	A90	N10	TOTAL	P95	P100	B5	A40	P20	A15	N10	N20		
<i>Cicadellidae</i>	D6	1				1		2			4										
	D7	2	22				30		58	1	113	1									
	D9	1									1										
	D37	2									2										
	D53										2										
	D65			1				5			5										
	D93	2	1				1				1										
	D94			1					1		5										
	D103	3	2								1										
	D113	2									5										
	Others	38	40	79	24	11	7	63	3	58	4	327	1		1	3	33	3	2	41	369
<i>Membracidae</i>	D15	6	6	2			3	9	3	1	30	2	9	11							
	D16	1	2				4	1	1		9										
	D18										1										
	D69	10	2	1							13										
	D104	1									1										
	Others	2	5	5	1		6	1		20	2				2	2					
<i>Derbidae</i>	D3a	5	8	7	2	7	5	13	1	48	1	3	4								
	D3b	9	13			18	1	10		51	2	2									
	D5									4											
	D27	1	1				1	2	1	4											
	D50	1	1							3											
	Others	3						1		4											
<i>Cixiidae</i>	D2	1								1											
<i>Flatidae</i>	D14	2								2											
Others		15	2	13	3	1	4	3	16	2	59	7			7	3	2	2	7	14	80

*) Coconut

A = *Homolepis aturensis*B = *Paspalum conjugatum*

G = Gramineae

N = Natural vegetation

P = *Pueraria*

Appendix 8. Comparison of fauna in different plantations in Brazil; species that appear to be similar.

Family	DENPASA		CODEPA		SOEFINCO		EMADE		ERRU		AGROMENDES CRAI	
	BENEVIDES PA	P. GRANDE AP	P. GRANDE AP	ALVARAES AM	TEFÉ AM	R. PRETO DA EVA AM	ACARA PA	MOJU PA				
<i>Cicadellidae</i>	D6	M1		S12		E6					A25	C16
	D7	M15									A13?	
	D10			S22								
	D11	M23										
	D37										A7	C5
	D39	M31				E7						
	D47	M29		S16		E18						
	D49	M24									A19	
	D51										A20	C17
	D52	M17										
	D67	M22										
	D74			S2?								
	D75											C24
	D77	M28										
	D79											C30
	D93											C27?
	D106	M8										
	D109	M5										
	D132											C8
	D156											C29
<i>Membracidae</i>	D15	M4		S7		E12			U10		A18	C15
	D17											
	D18											C10
	D21										A9	C6
	D54			S6								
	D69										A15	C34
	D70										A24	
	D104										A11	C22
	D123											C21
<i>Derbidae</i>	D1	M37		S1		E3			U6		A1	C1
	D3a	M3									A3	C3
	D3b					E2			U1		A2	C2
	D4					E4					A4	C4
	D5					E5					A5	
	D12	M18										
	D24	M19										
	D27	M6										
	D44	M14				E1						
	D50	M35		S26?		E8			U3?			
	D102			S5?								
<i>Cixiidae</i>	D46										A17	C9
<i>Flatidae</i>	D14	M33									A14	
<i>Delphacidae</i>	D25	M27										

Abstract

Inventory of Homoptera and Heteroptera in relation to the Amarelecimento Fatal disease. An inventory was made of *Homoptera* spp. and *Heteroptera* spp. which appear to be related to the Fatal Yellowing Disease of the African Oil Palm (*Elaeis guineensis*) in Brazil.

The insects were gathered from oil palm with vials and yellow traps and from the crown with an entomological net and emergence cages. This was done in both healthy areas and areas of foci.

Up to February 1988, 187 species of Homoptera had been found together with 55 species of Heteroptera of which 12 species of Homoptera are considered suspects.

Resumen

Inventários de Homopteros y Heteropteros con relación a la enfermedad amarillamiento fatal. Los insectos fueron colectados en palmas africanas con frascos y con trampas amarillas y en la cobertura frascos redes entomológicas y con jaulas de emergencia.

La colectas fueron hechas tanto en áreas sanas como en áreas de foio. Hasta el mes de febrero de 1988 fueron encontradas 187 especies de Homopteros y 55 de Heteropteros dentro de las cereales 12 especies de Homopteros son consideradas como sospechosas.

Resumo

Inventários de Homopteros e Heteropteros com relação a doença Amarelecimento Fatal. Os insetos foram coletados em dendê com frascos e armadilhas amarelas e na cobertura com rede entomológica e com gaiolas de emergência. As coletas foram feitas tanto em áreas saudáveis como em áreas do foco. Até o mês de fevereiro de 1988, foram encontradas 187 espécies de homópteros e 55 de heterópteros, dentro das quais 12 espécies de homópteros são consideradas suspeitas.

Discussion

Ruinard: Are collected insects checked on suspected organisms possibly responsible for spear rot?

Louise: No. Neither the vector nor the causal organism are known.

STUDIES OF POSSIBLE INSECT TRANSMISSION OF AMARELECIMENTO FATAL IN OIL PALM¹

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1. Introduction

The hypothesis that insects may be involved in the transmission of Amarelecimento fatal in the oil palm in Brazil would seem to be highly significant, particularly when one suspects the involvement of micro-organisms of the micoplasma, virus and viroid types.

This hypothesis can be further strengthened by the manner in which the disease spreads. It tends to follow the direction of predominant winds, while natural barriers, such as roads, rivers and clearings, are unable to hinder dissemination, thus demonstrating that the disease spreads through the air.

Insects, particularly *Homoptera*, as vectors of different types of micro-organisms, have been shown to participate in the spreading of other diseases in oil palm and coconut in Latin America and other parts of the world.

A good example is the lethal yellowing disease of the coconut palm in the southern part of the United States (Florida) and Central America (Caribbean Islands). In this case, the species *Myndus crudus* is the vector of a mycoplasma (McCoy et al, 1983). *My-*

ndus tafini is responsible for the transmission of a leaf disease that afflicts the coconut palm in the archipelago of Vanuatu (Julia, 1982; Julia et al. 1985).

In observations in plantations affected by the disease in the municipalities of Alvarães (AM) and Benevides (PA) and in inventories of insects in these and other localities of Brazil, the following species have been classified as suspicious: D1, D3a, D3b, D27, D50 (*Derbidae*); D31 (*Delphacidae*); D2, D46 (*Cixiidae*); D14 (*Flatidae*); D65, D93 and D105 (*Cicadellidae*).

Initially, the principal insects suspected of being responsible for transmission were the *Derbidae* D1 (Hsp1) and the *Cixiidae* D2 (Hsp2) due to the fact that they are commonly found in the oil palm. More specifically, part of the life cycle of these insects depends on the oil palm for nourishment. They were identified as *Persis* sp. and *Myndus crudus* respectively.

With the progress of inventory work, other insects came to be included in the transmission tests.

Among these were the D3a, D3b (identified as *Omolichna* sp.) D27 and D50.

The objective of the investigations described in this paper is to attempt to

1) Study carried out with the financial participation of EMBRAPA-APRODEN and DENPASA.

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