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"RED RING" DISEASE IN SURINAM[1]

„Red ring"-ziekte in Suriname

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In Surinam no red ring disease in coconut, caused by the nematode *Rhadinaphelenchus cocophilus*, could be found under natural conditions. An inoculation experiment with the nematode in coconut palm and an experiment in oil palm where an entry for the vector *Rhynchophorus palmarum* was made, resulted in red ring symptoms. Collection of weevils of the species *R. palmarum* in coconut and oil palm plantations and in wild vegetation, showed that both vectors and nematodes occur in considerable numbers. The slow development of red ring in the inoculation experiment and of little leaf – another symptom, caused by *R. cocophilus* – in a period of excessive drought might give an explanation for the absence of red ring in Surinam. In the main coconut growing areas rainfall is poor as compared with other coconut-growing countries in the Caribbean.

INTRODUCTION

The red ring disease, caused by the nematode *Rhadinaphelenchus cocophilus* (Cobb) is of economic importance for the cultures of the coconut palm, *Cocos nucifera*, and of the oil palm, *Elaeis guineensis*. This disease has been recorded in Trinidad, Tobago, Barbados, Grenada, St. Vincent, British Honduras, Panama, Columbia, Venezuela, Brazil and British Guiana (NOWELL, 1923; FENWICK, 1959; OOSTENBRINK, 1963) and has also been found in other palms e.g. in an unidentified species of *Cocos* (NOWELL, 1923). FENWICK (1959) stated that the red ring nematode attacks coconut palms, oil palms and quite a number of *Oreodoxa* palms, including the royal palm.

Although Surinam has about 1700 ha under coconut palms of which 700 ha mostly older than 30 years concentrated in Coronie and ca. 50 ha oil palm of the type Deli Dura concentrated in Lelydorpplan planted ca. 1954, so far no red ring symptoms have been found.

However, VAN HOOF & SEINHORST (1962) discovered in 1962 that in Surinam *Rhadinaphelenchus cocophilus* caused typical little leaf symptoms in oil- and coconut palms without red ring symptoms. Recently this nematode has been found in some specimens of *Rhynchophorus palmarum* collected at Coronie and Lelydorpplan. According to FENWICK (1962) this beetle is a vector of the disease in Trinidad.

To answer the question to what extent red ring disease could become a menace to future expansion of coconut- and oil palm culture the present investigations were performed.

INOCULATION EXPERIMENTS WHIT *RHADINAPHELENCHUS COCOPHILUS*

In the past the only successful inoculation in Surinam was made by VAN HOOF (1962). During the wet season he placed a nematode suspension on the young

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leaves of five oil palms about ten years old. After some time one palm showed little leaf symptoms. Fifteen months after the inoculation the tree was felled. It showed no red ring symptoms.

Elsewhere inoculation experiments in the stem resulted in red ring symptoms. In Venezuela MALAGUTI e.g., as mentioned by OOSTENBRINK (1963), successfully inoculated coconut palms with nematodes extracted from oil palms and the reverse.

The present authors carried out the following experiment. In each of two groups of four coconut palms of the tall variety, five to eight years old, growing with their boles against each other, one palm was inoculated in March 1963. Pieces of leaves with the brown patches from an oil palm with little leaf were inserted in a hole drilled in the stem and closed with wax afterwards. No external symptoms developed, but one tree felled in January 1964 had a red ring.

The red ring tissue contained *Rhadinaphelenchus cocophilus*. In the other group the inoculation was also successful and a red ring occurred even in one of the closely neighbouring, not inoculated trees, which proves the possibility of root infection. In one case the upper part of the stem, ca. 2 m high, was hollow and the surrounding red tissue contained nematodes. The crown, however, was still intact, with only one brown and one green leaf bending down. The trees were still without other external symptoms when felled, ten months after inoculation. The extreme drought of that season may have caused this delay (see Table 1 and the discussion), because it is reported from Trinidad that a tree dies within three to five months.

TABLE 1. Monthly precipitation in mm at Paramaribo from March 1963 to December 1963, compared with the monthly means from 1931 to 1960.
Neerslag per maand in mm in Paramaribo van maart 1963 tot december 1963, vergeleken met de maandelijkse gemiddelden van 1931 tot 1960.

	March	April	May	June	July
1963	69.8	74.0	179.2	370.0	143.2
1931–'60	162.2	231.9	321.0	302.7	225.6
	August	Sept.	Oct.	Nov.	Dec.
1963	180.5	40.4	84.7	52.7	142.2
1931–'60	166.8	85.9	86.7	108.6	173.9

In the stumps of the inoculated trees larvae of *Rhynchophorus palmarum* were found in April 1964. This indicates that the factors for a spreading of the red ring disease in coconuts exist in Surinam because 1. both nematodes and vectors are present, 2. the "little leaf nematode" produces a red ring. For some reason this symptom does not normally occur in the field, or on a scale that escapes attention. There is another way in which oil palms can contract red ring disease i.e. natural infection with optimal conditions for the penetration of the vector into the tree. This was shown by the following experiment. From two rows, in the oil palm estate at Lelydorpplan, a small part of the stem was deprived of the dead leaf axils and the cortex in September 1964. Weevils were collected from these wounds three times daily. In March 1965 13 out of 79 damaged trees declined in a few weeks (Fig. 1).

Of the 13 declining trees 8 were examined and they all contained a ring and specimens of *Rhadinaphelenchus cocophilus* in stem and petioles (Fig. 2). The ring is yellow at the inside, where most nematodes are present and dark brown at the outside. Using the picture of these declining trees as a standard the neglected oil palm plantation (ca. 6000 trees) was inspected and ten suspected trees were examined. Only one case was found in which petioles harboured red ring nematodes.

THE PRESENCE OF VECTORS IN SURINAM

From 3/4 m cleft stem pieces of oil palm and coconut palms, laid on the ground for use as a bait, the weevils were collected and counted. This started in August 1964. For an impression of the number of weevils collected, see Tables 2 and 3. Weevils belonging to the genera *Metamasius* and *Hololepta* were also collected but were omitted from the tables as no nematodes were found on them. HAGLEY (1963) also found that these weevils are of little significance as vectors of the disease.

TABLE 2. Numbers of *Rhynchophorus palmarum*, collected at Lelydorpplan in an oil palm and in a coconut palm estate, 1964.
Aantallen Rhynchophorus palmarum, *gevangen in het Lelydorpplan in een olie- en in een kokospalmaanplant, 1964.*

Date/*Datum*	15/9	16	17	18	19	20	21	22	23	24	25	
Oilpalm	20	10	17	12	13	7	12	14	19	12	8	
Coconut	–	–	–	–	–	–	1	0	0	6	7	
Date/*Datum*	26/9	27	28	29	30	1/10	3	4	5	6	7	8
Oilpalm	7	–	1	8	2	2	–	–	12	20	15	0
Coconut	0	–	0	3	0	2	–	–	0	0	11	2

TABLE 3. Numbers of *Rhynchophorus palmarum*, collected in the main coconut district Coronie by means of stem pieces of oil palm.
Aantallen Rhynchophorus palmarum, *gevangen in het kokosdistrict Coronie door middel van als lokaas neergelegde stukken hout van oliepalm.*

Oct. 1964	2/10	3/10	4/10	5/10	6/10	7/10
	24	7	3	3	41	37

It may be assumed that there is a sufficient number of weevils to spread the nematodes causing red ring once these have invaded an area. They have been collected after an extremely long period of drought. The higher numbers found in the oil palm estate of Table 2 as compared with those found in the coconut palm estate may have been caused by a higher population density in the former case or by a difference in attractiveness of the baits available. In order to compare the effectivity of oil and coconut stem as a bait, an oil palm and a coconut palm were felled on the same day and stem pieces were laid out one meter apart. Table 4 shows the numbers of weevils collected.

The stem of oil palm appeared to be more attractive than that of coconut

TABLE 4. Numbers of *Rhynchophorus palmarum*, collected in pieces of oil palm and of coconut palm at Lelydorpplan.
Aantallen Rhynchophorus palmarum, *gevangen in stukken hout van olie- en kokospalm.*

	5 Oct. 1964	6	7	8	Total
Oil palm	9	6	24	2	41
Coconut	3	4	2	0	9

palm. Probably pieces of oil palm can be used successfully as a bait for trapping the weevils in coconut plantations.

From August to January, up to the end of the experiment, weevils were regularly collected both in Coronie and at Lelydorpplan. Therefore it is not probable that the absence hitherto of red ring in Surinam is caused by an insufficient density of a vector population.

Most of the weevil population probably originates from the surrounding forests where many host plants occur (DA COSTA LIMA, 1956).

The oil palm estate at Lelydorpplan is about 50 ha, surrounded by scattered oil- and coconut palms. Coronie has 700 ha coconut palm, bordered by sea and swamps. In the latter the "Mauritie" palm, *Mauritia flexuosa*, is abundant in many small scattered groups. On felled palms in these groups far more specimens of *Rhynchophorus palmarum* were collected than in the coconut belt.

RHYNCHOPHORUS PALMARUM AS A VECTOR IN SURINAM

As mentioned the nematode *Rhadinaphelenchus cocophilus* was only found on *Rhynchophorus palmarum*. On 13 weevils 229 nematodes were counted. These weevils were collected on October 7th and 8th on stem pieces of oil palm, laid out in a small coconut estate at Lelydorpplan. Before this day only a few specimens of *R. cocophilus* were found on the weevils. After this day they were regularly collected on them.

To determine the numbers of nematodes on and inside the weevils the method for examination of cores of coconut palm tissue published by FENWICK (1963) was used. The numbers given in Table 5 are from nematodes on and in the weevils. In the beginning the weevils were examined collectively but since December 12th 1964 this was done individually.

The 1780 specimens mentioned in the top line of Table 5 give a mean of over hundred nematodes per weevil, which is comparable with the ca. 80 mentioned by HAGLEY (1963). On weevils collected 100 km inland, at Brokobaka, no nematodes were found.

It must be emphasized that rainfall was above normal in the coastal area during the period of investigation, August 1964 to February 1965. This is important, as *R. cocophilus* is sensitive to drought.

Although contaminated weevils were collected in Coronie and at Lelydorpplan no coconut or oil palm with red ring symptoms could be found. By means of stem pieces of oil palm and Mauritie palm, contaminated weevils were also collected in two accessible groups of Mauritie palms in the swamps south of the coconut belt in Coronie.

In the stem of a young declining Mauritie palm and in the stumps of two

TABLE 5. Examination of samples of *Rhynchophorus palmarum* for the presence of *Rhadinaphelenchus cocophilus*.
Onderzoek van monsters Rhynchophorus palmarum *op de aanwezigheid van* Rhadinaphelenchus cocophilus.

Date *Datum*	Place *Plaats*	Vegetation *Begroeiing*	Number of weevils *Aantal kevers*	Number of *R. cocophilus* *Aantal aaltjes*
	Weevils collectively blended *Kevers per vindplaats gehomogeniseerd*			
Oct. '64	Coronie	Coconut	16	1780
Oct. '64	Lelydorpplan	,,	?	20
26 Oct. '64	,,	Oilpalm	6	187
28 Oct. '64	,,	Coconut	2	31
2 Nov. '64	,,	,,	8	126
3 Nov. '64	,,	,,	26	196
3 Nov. '64	,,	,,	4	0
12 Nov. '64	,,	Oilpalm	18	113
14 Nov. '64	Coronie	Coconut	16	977
14 Nov. '64	,,	,,	5	0
21 Nov. '64	Lelydorpplan	,,	3	1
30 Nov. '64	,,	,,	10	287
30 Nov. '64	,,	Oilpalm	13	17
1 Dec. '64	,,	,,	9	111
1 Dec. '64	Coronie	Coconut	1	0
1 Dec. '64	,,	,,	8	1371
	Weevils individually blended *Kevers apart gehomogeniseerd*			
14, 15 Dec. '64	Coronie	Mauritie	4 × 1	–
14, 15 Dec. '64	,,	Coconut	12 × 1	1 × 171
8, 15, 16, 17 Dec. '64	Lelydorpplan	,,	4 × 1	1 × 1
7, 10, 16 Dec. 64	Lelydorpplan	Oilpalm	3 × 1	1 × 11
16, 17, 19 Dec. '64	Coronie	Mauritie	13 × 1	1 × 36, 1 × 2
16, 17, 19 Dec. '64	Larecopolder	,,	7 × 1	–
16 Dec. '64	,,	Coconut	3 × 1	–
17, 19 Dec. '64	Coronie	,,	6 × 1	–
10 Febr. '65	,,	Mauritie	1 × 20, 1 × 1	1 × 17
15 Febr. '65	Lelydorpplan	Forest	1 × 8	–
15 Febr. '65	Rijsdijkweg	,,	3 × 1, 1 × 3	1 × 83, 1 × 30
5 Febr. '65	Baboenhol (70 km inland)	,,	1 × 48	–
22 Febr. '65	Coronie	Mauritie	1 × 1	1 × 258

Mauritie palms felled in September 1964 in the white sand savanne near the airport Zanderij (Fig. 3) both *R. cocophilus* and larvae of *R. palmarum* were found. So probably the disease is endemic and the nematodes occur in wild palms or other monocotyledonous plants (DA COSTA LIMA, 1956).

DISCUSSION

From the data mentioned above it can be concluded that all the factors necessary for the occurrence of red ring disease are present in Surinam. That the disease has not so far occurred naturally in Surinam plantations may be due to several factors.

Coconut replanting in Coronie for instance is only practiced on a small scale, so the majority of the trees is older than 30 years. Probably, however, it is not only the age of the trees that counts for the absence of red ring, because a similar situation as in Surinam exists in the eastern part of British Guiana where replanting is practiced. There are also practically no red ring symptoms, but little leaf occurs there in coconut palms, as rare as in Coronie.

Recently, however, the disease established itself on a coconut plantation near Georgetown (BISSESSAR, personal communication). From this observation and from the presence of *R. cocophilus* and its vector and the occurrence of a red ring in our inoculation experiments, it must be concluded that the red ring disease can get established in coconut and oil palm in Surinam. That the little leaf symptoms never develop into red ring can be explained for the coconuts by the fact that they are too old. In one little leaf coconut of about 30 years old a shallow ca. two cm red ring was found in the young tissue just below the bud. No nematodes, however, could be found in it. The oil palms under observation are about ten years old now, so age is not an explanation as is shown by the infection via wounds, artificially made in the stem, as mentioned above.

Another reason for the reduction in the natural spread of red ring in Surinam may be the climate. Fig. 3 shows that the rainfall from west to east changes from a type with one top in November via a type with two wet seasons into a type with one wet season again, but in March (Belem). This is only true of the coastal areas. More inland the rainfall is more intensive with shorter dry periods. In the area between Georgetown and Paramaribo the dry periods twice a year can be severe and be fatal to the nematodes, specially those carried around on weevils. The areas near the sea, such as Coronie, have the best climatological barrier, due to often long dry periods. Red ring occurs in Grenada, Tobago, Trinidad, Morawhanna, Belem and recently near Georgetown.

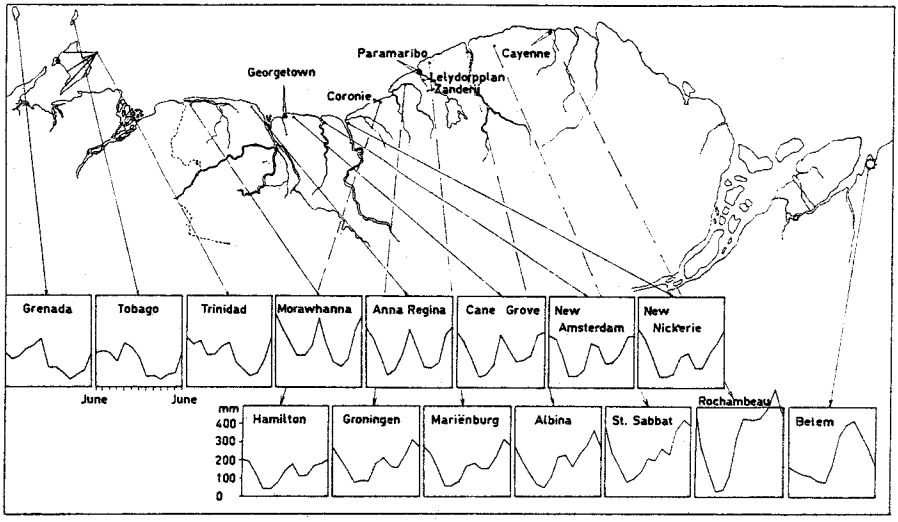

FIG. 3. Periodicity of the rainfall in the Caribbean area.
Periodiciteit van de regenval in het Caribische gebied.

It is possible that the occurrence of a dry period twice a year prevents the occurrence of an effective contamination in weevils to spread the disease. The irregularity of the climate must also be taken into account which means that the length of a dry period often differs from the mean and strengthens the drought effect. This may also explain why a palm with little leaf can survive the attack, and form a normal crown, or stand for years with a little leaf crown.

Schemes for further increase of the areas where coconut and oil palms are grown in Surinam therefore must take into account the possible occurrence of this disease. Planting must be done only on a large scale, because of the better opportunities for insect control on plantations than by smallholders. The commonly practiced pruning of the oil palm needs further attention as it results in many fresh wounds through which infection can take place.

Another peculiar point is that most of our coconut and oil palms harbour larvae of the moth *Castnia dedalus*, a serious pest in Surinam, which does not occur in Trinidad, and in British Guiana to a lesser extent than in Surinam. These larvae reach the size of a man's finger, tunnel in the leaf axils and the upper part of the stem (Fig. 2), leaving a big opening after emerging to pupate. For some unexplained reason these entrances are not used by *Rhynchophorus palmarum* and therefore play no part in the spreading of red ring. Trees attacked by *Castnia* larvae can successfully be inoculated by placing *R. cocophilus* in a freshly drilled hole. In the wall tissue of the *Castnia* holes no plant parasitic nematodes were found.

SAMENVATTING

In Suriname kon de aantasting van de kokospalm, bekend onder de naam „red ring disease" en veroorzaakt door het aaltje *Rhadinaphelenchus cocophilus*, niet gevonden worden. Kunstmatige infectie van kokospalm met aaltjes en een proef met oliepalm waarbij het binnendringen van de vector van *R. cocophilus*, de kever *Rhynchophorus palmarum*, vergemakkelijkt werd, resulteerden beide in de ontwikkeling van het „red ring"-symptoom (fig. 1 en 2). Vangproeven waarbij kevers van de soort *R. palmarum* werden verzameld in plantages en bossen toonden aan, dat zowel de kevers als de aaltjes in aanzienlijke aantallen voorkomen (tabel 2 tot en met 5). Wilde palmen en andere Monocotylen zijn eveneens belangrijke waardplanten voor *Rhynchophorus palmarum*. Het is mogelijk dat het optreden van een in lengte variërende droge periode twee keer per jaar een besmetting der kevers, voldoende om de ziekte te verspreiden, tegengaat en een destructieve ontwikkeling van een ander symptoom der ziekte, „little leaf", remt.

In the gebied waar de meeste kokosplantages zijn geconcentreerd, het district Coronie, is de regenval gering vergeleken met andere kokos producerende streken in en om het Caribische gebied waar deze ziekte veelvuldig voorkomt (fig. 3). Bij het ontwerpen van plannen voor kokos- en oliepalmplantages op plaatsen verder van de kust moet met de aanwezigheid van parasiet en vector rekening worden gehouden. Als de voorwaarden voor de verspreiding en de ontwikkeling der aaltjes aldaar gunstiger zijn, zou de „red ring"-ziekte er ernstiger kunnen optreden dan nu in Suriname het geval is. Ook de cultuurmethoden behoeven in verband hiermee nader onderzoek.

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