

Cape Saint Paul Wilt Disease of Coconut in Ghana: Surveillance and Management of Disease Spread

Surveillance et Gestion de L'Extension de la Maladie du Cocotier de Cap Saint Paul au Ghana

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Abstract:

The Cape Saint Paul wilt disease (CSPWD), a lethal-yellowing type disease of coconut has been in Ghana since 1932. Aerial and / or ground surveys were undertaken to assess the current status of the disease spread. The survey revealed that the spread of the disease for the past five years has mainly been the expansion of existing foci. New outbreaks were however, identified at Glidzi in the Volta, Bawjiase and Efutu Breman in Central regions. After the resurgence in the Volta region in 1995 the Woe-Tegbi-Dzelukope corridor has remained endemic, but less aggressive. Pockets of healthy groves remain along all the coastline and inland of known disease zones. Eradication of diseased palms at Ampain focus lying just about 60 kilometres to the Ivorian border and disease situations on new replanting with MYD x VTT hybrid are discussed.

Key words: Cape Saint Paul Wilt Disease, Coconut, Aerial survey, Disease management.

Résumé :

Le Cape Saint Paul Wilt (CSPWD), une maladie du cocotier de type Jaunissement mortel, est connu au Ghana depuis 1932. Des surveillances aériennes et/ou terrestres ont été entreprises pour évaluer l'état actuel de la dissémination de la maladie. Les enquêtes ont révélé que la diffusion de la maladie, pendant les cinq dernières années, a surtout été l'extension des foyers existants. De nouveaux foyers ont cependant été identifiés à Glidzi dans la Région Volta, Bawjiase et Efutu Breman en Région Centrale. Après la réapparition de la maladie dans la Région Volta en 1995, le corridor Woe-Tegbi-Dzelukope est resté endémique, mais moins agressif. Des poches de cocoteraies saines subsistent tout le long des côtes et à l'intérieur des terres dans les zones connues de maladie. L'éradication de cocotiers malades à Ampain, foyer situé à 60 kilomètres environ de la frontière ivoirienne et la situation de la maladie dans les replantations d'hybrides NJM x GVT sont mentionnées.

Mots Clés : Maladie du Cap Saint Paul, Cocotier, Etude aérienne, Gestion de la maladie

Resumen : “La enfermedad de Marchite Cape Saint Paul del Cocotero en Ghana: Vigilancia y Gestión de la Propagación de la Enfermedad”

El marchite de Cape Saint Paul (CSPW), una enfermedad del tipo de la del amarillamiento mortal del cocotero, ha estado presente en Ghana desde 1932. Se llevaron a cabo estudios aéreos y/o terrestres para evaluar el estado actual de la propagación de la enfermedad. El estudio reveló que la propagación de la enfermedad durante los últimos cinco años ha sido, principalmente, la expansión de los focos existentes. No obstante, se identificaron nuevos brotes en Glidzi, en la región Volta y Bawjiase y Efutu Breman en la región Central. Después de un resurgimiento en la región Volta en 1995, el corredor Woe-Tegbi-Dzelukope ha permanecido endémico, pero menos agresivo. Quedan focos de arboledas sanas a lo largo de todas las zonas costeras y del interior de zonas enfermas conocidas. Destacan la erradicación de palmeras enfermas en el foco de Ampain situadas a unos 60 kilómetros de la frontera marfileña y la situación de enfermedad en las nuevas parcelas repobladas con híbridos MYD x VTT.

1. Introduction

The Cape Saint Paul wilt disease (CSPWD), a lethal-yellowing type disease of coconut has been in Ghana since 1932. The disease is caused by a phytoplasma and is found in Africa and the Caribbean. The symptoms of the disease are: premature nut drop with or without yellowing of fronds, blackening of immature inflorescences. This is followed by progressive yellowing or in some instances browning of the crown from the older leaves upwards. Eventually the crown turns yellow, dries up and then falls off, leaving a bare trunk or 'telephone pole'.

Two types of spread of CSPWD have been observed. In one case, a local centre of infection appears in one or two palms; this is followed by new cases appearing at random around the initial centre. The second is a 'jump spread' whereby the disease appears at a spot remote from a known focus. This is then followed by a local spread in all directions.

The disease epidemic which began around Cape Saint Paul in Woe near Keta destroyed thousands of coconut palms and caused the collapse of the coconut industry in the Volta region by the mid-1950's (Leather, 1959). The disease appeared in the Western region at Cape Three Points in 1964 and in the Central region at Ayensudo in 1983. The history, occurrence, epidemiology and spread of the disease in Ghana have been reported by Johnson & Harries (1976), Ofori & Nkansah-Poku (1997) and Dery *et al.* (1999).

McCoy *et al.* (1976) pointed out that most secondary spread of lethal yellowing disease occurs within 100 metres of a new focus and eradication could be useful if practiced rigorously in the early stages of the outbreak. Philippe *et al.* (2004) and Nkansah-Poku *et al.* (2005) observed that cutting out regularly all diseased palms slows down the rate of spread of CSPWD.

Since 2000 the damage and spread of the disease have been monitored through disease surveys. In 2006 and 2007 an aerial surveillance was conducted to have a quick view of the extent of the disease spread in the Western region. These were the only occasions ever of monitoring the CSPWD spread with an aircraft in the country. The disease has also been managed by removal of diseased palms in a focus at Ampain to reduce the disease spread westwards to protect the large healthy plantings beyond Ampain.

The hybrid between the 'Malayan Yellow Dwarf' and 'Vanuatu Tall' (MYD x VTT) was utilised in a rehabilitation programme in 1999 following a recommendation by Dery *et al.* (1995). Between 1999 and 2004, 1300 hectares of devastated areas were replanted with this hybrid in the Western and Central regions.

This paper reports on the aerial surveillance, the current disease distribution in the Volta, Central and Western regions, the containment of the disease at Ampain as well as the disease situation on new replanting plots with the hybrid, MYD x VTT.

2. Materials and methods

2.1. Cape Saint Paul Wilt Disease survey

2.1.1. Aerial surveillance

A small 2-seater ULM aircraft was used in the survey. The aircraft moved at an average speed of about 35 m/s and at a height of approximately 300 metres. Waypoints of suspected diseased coconut palms / foci spotted from the aircraft were recorded with a GPS. Recorded waypoints were estimated in metres to the left, centre or right of the aircraft from the spotted diseased palms / foci and managed with Map Source software for assessment and ground verification. Photographs were also taken of suspected CSPWD infection spots. The aircraft flew along designed flight patterns worked out by the researcher and the pilot.

2.1.2. Ground surveillance

Two types of ground survey were conducted. The first was an extensive survey which was aimed at covering all the coconut growing regions. In this type we made use of accessible footpaths and motorable routes in an area to inspect coconut plantations. Village enquires and interviews of farmers and Agriculture Extension Agents were carried out to gain information on the presence or absence of the disease in an area. The second was an intensive survey aimed at identifying diseased spots and or individual diseased palms in an infected plantation or nearby healthy farms which are at risk of getting infected. The “systematic walk through” method was used to locate palms with visible CSPWD symptoms in an area. Samples of infected palms were taken for Polymerase Chain Reaction (PCR) analysis to confirm disease incidence. Known diseased foci were monitored monthly in this way. GPS points captured during aerial surveillance were also located and verified by this method.

2.2. Disease management/containment

To reduce the rate of spread of the disease, eradication of diseased palms was undertaken at the Ampain focus. There is a continuous stretch of coconut planting from this focus westwards to Cote d’Ivoire. The focus was monitored periodically; and monthly in times of sufficient logistics. During each visit palms were inspected and any one showing disease symptom was felled with a chain saw machine, fronds pruned off and trunk cut into pieces of a metre long to facilitate quick drying.

2.3. Monitoring of Coconut Sector Development Project (CSDP) replanted plots

The CSDP of the Ministry of Food and Agriculture (MoFA) started a rehabilitation programme with the hybrid, MYD x VTT from 1999 and 1300 ha were replanted by 2004 under a project funded by *Agence Francaise de Developpement* (AFD). All fields replanted with the hybrid were monitored between March 2006 and May 2007 through monthly inspections. All cases of disease development based on visual symptoms were recorded. First infection cases in each plot were verified and then confirmed by PCR analysis.

3. Results

3.1. Aerial surveillance

Two surveys were conducted, the first from 28th -31st August 2006 and the second, 25th - 30th March 2007. The first survey was conducted in the area denoted as “Established infection area” (Fig. 1). Two incipient foci were revealed by that survey; one to the north and the other to the west of Asaman 15.2 km and 11.2 km away from the coast respectively, following ground verification of points captured with GPS. These foci were beyond the previously known disease front. In the second survey the area covered extended close to the frontier with Cote d’Ivoire but 2 km away from the border for security reasons. The disease appeared to have established itself in the approximate pattern shown in figure 1. The extent of the survey is denoted by the mauve line, and the areas of possible and established infection delimited in red. The green delimited area was not surveyed since it appeared to be a ‘coconut free zone’. The ‘possible new infection area’ had coconuts with a general yellowing tinge to the lower leaves over a large area which runs down towards the frontier with Cote d’Ivoire. Isolated cases of yellowing were also found in other areas.

3.2. Ground verification survey

Using the data captured on the GPS and the aerial photographs (Plate 1) taken during the flights, ground survey for the verification of the GPS captured disease symptoms were conducted in the area marked “possible new infection area” and beyond Half Assini all the way to the frontier. A thorough ground search identified GPS points 041 (south-east of Tikobo 2) and 167 (near Half Assini). Samples from representative CSPWD suspected palms within the designated area were taken for PCR analysis. A total of 6 samples from 6 locations were analysed. Morphology of the sampled palms ranged from symptoms of pronounced yellowing reminiscent of nitrogen deficiency, yellowed lower crown with dark spotting in the lamina

resembling symptoms of potassium deficiency and pale crowns with tapering trunks as in senile palms on poor soil. All the palms tested negative, thus confirming the absence of the disease in these palms.

A critical observation of these ‘suspected disease’ outbreak points revealed that apart from 2 locations, where there were intercropping with maize, cassava and vegetables, all the palms had been left to grow without any agronomic intervention and were associated with bushy undergrowths. All the target palms were West Africa Tall (WAT) ecotypes above 40 years and showing poor nut loads. Apart from yellowing of lower leaves, no other symptom, for example nut drop or necrosis of opened inflorescences, was observed in any of the suspect palms.

Figure 1. Area covered by aerial surveillance.

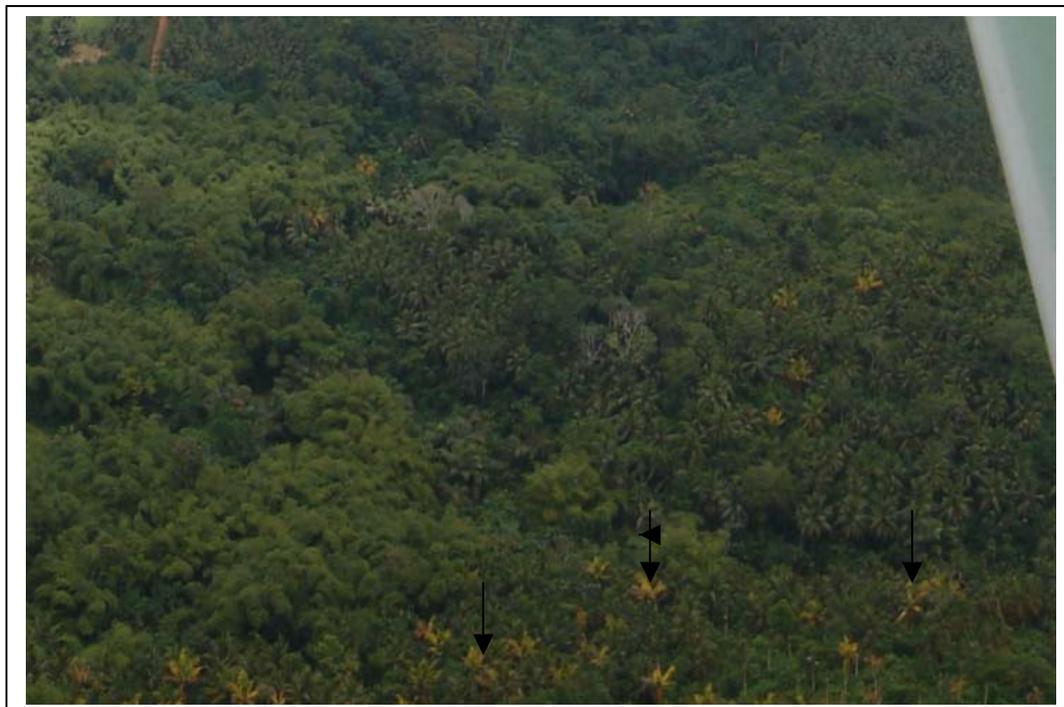
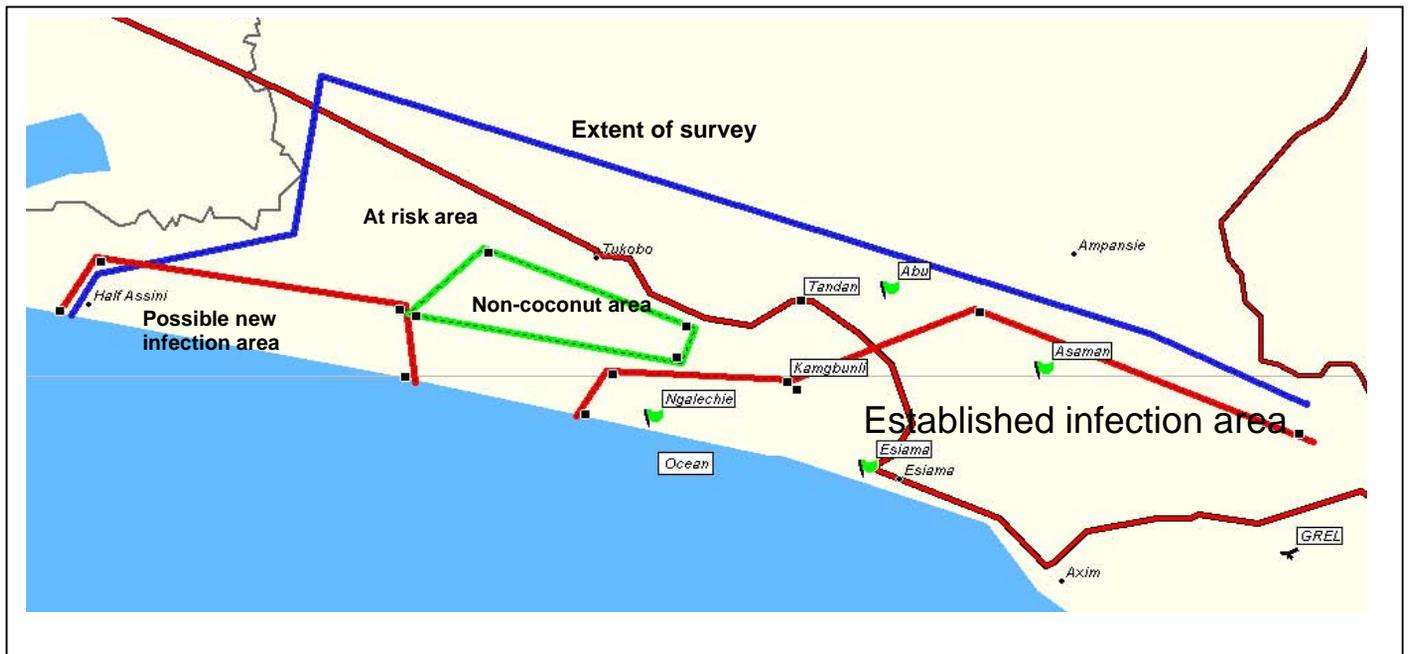


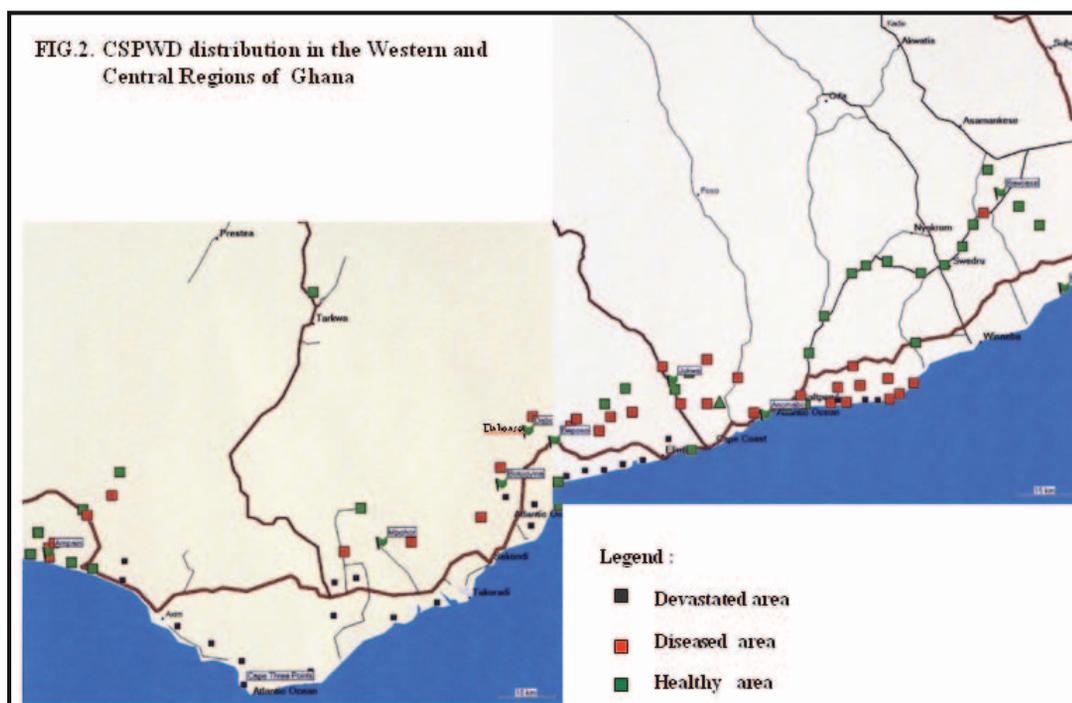
Plate 1. Photograph taken during the aerial survey showing diseased palms (arrowed).

3.3. Limit of spread of CSPWD

The disease zone stretches from Ampain in the West to Keta in the East along the coast. However, there are pockets of healthy groves remaining in between and further inland. The figures 2 & 3 show the current distribution of the CSPWD incidence in Ghana.

3.4. Disease distribution in the Western Region

The worst affected district in the region is the Ahanta West which has lost about 70 % of its coconut plantings. Few healthy groves now exist and the disease appeared less active in existing foci.



The most active foci are located in the Nzema East district. The Asanta focus appeared in 1992 and by 2001 had almost devastated all the coconuts in the area (90 % loss) crossing the River Ankobra lying in the east to merge with the Awuku focus established in 1990 which had spread westwards through Axim . The Asanta focus has spread as far north as Nyamebikyere by 2006. Another focus at Ampain since its identification in 1995 has expanded the least in the district, despite the loss of 70% of the original 25 ha planting. 20 – 30% of the district's 12000 ha of coconuts are lost. Two other active foci in the region are located at Botogyina and Daboase (Fig. 2) in the Shama and Mpohor Wassa East districts respectively. The spread after 1995 has mainly been by expansion of existing foci rather than jump spread.

3.5. Disease distribution in the Central Region

In the Central, the disease was spotted at Ayensudo near Komenda in 1983. By 1995, there were several foci dotted in the KEEA district. These foci merged in 1998 and devastated all the plantings around Abrobiano, Duakyimase and Kafodzidzi. The foci at Dompouse, Ayensudo and Ataabadze lying north of Komenda also merged and spread to Hemang and Dwabor further north by 2003. The recent survey revealed only scattered infected fields with varied damage levels (1-70 %) in the northern part of the district where coconut plantations are not continuous- coconut plots are separated by food crop farms.

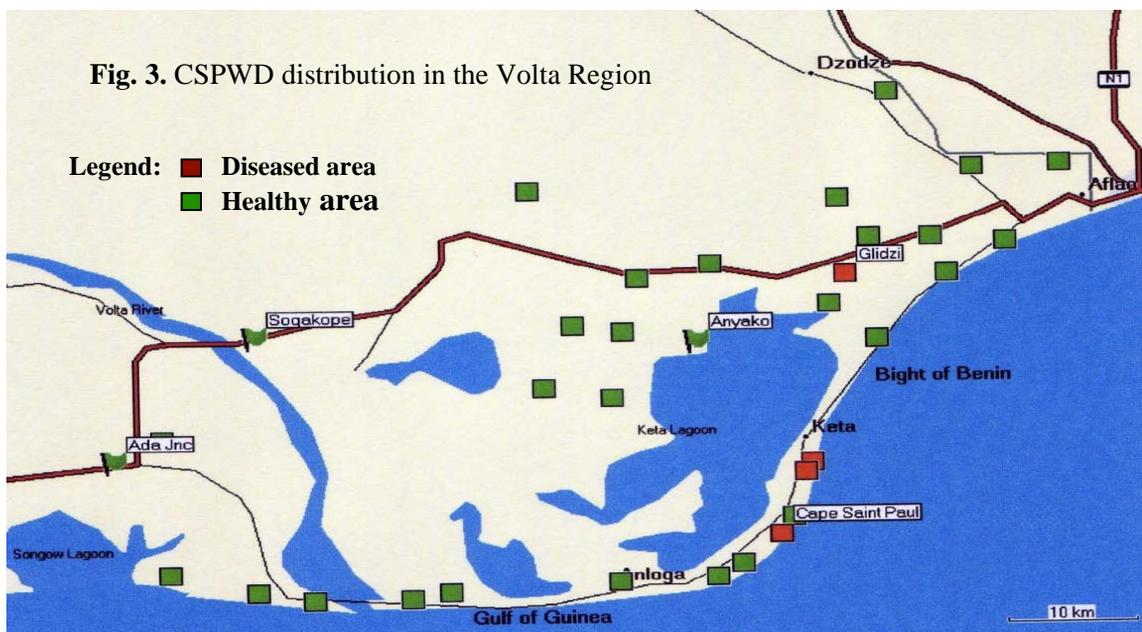
The Eduma focus established in 1989 had expanded north to merge with the Abakrampa focus engulfing the plantings at Asebu and its environs, reaching Asuansi in 2006. Another active disease centre of interest in the region is the Asaafa – Narkwa corridor. The disease occurred at Asaafa in 1998 and Narkwa in 1996. These

foci had since merged and devastated about 60% of the plantations as at April 2008. Beyond Narkwa towards the east the disease had spread to Mumford near Apam. The loss in this zone is about 40 – 60%.

The Agona district which was previously disease free is now affected. An outbreak occurred in 2006 near Bawjiase and about 650 palms (less than 1%) of the original stand had succumbed to the disease by April 2008. This focus is of importance because (1) it is at the centre of one of the extensive coconut groves in the region and (2) it seriously threatens the supply of fresh nuts to the city of Accra. Another outbreak occurred at Efutu Breman near Jukwa in 2005 and by 2008 devastated about 1.5 hectares.

3.6. Disease distribution in the Volta Region

In the Volta region the disease is currently less active with losses between 0-2 %. Existing disease foci are shown in figure 3. After the major epidemic in 1960's and 1970's in the Keta area, the disease apparently disappeared until 1995 when it resurfaced to attack replanted fields (Ofori & Nkansah-Poku, 1997). However, the disease after resurgence had been less aggressive and its attack is sporadic and mainly centred around the Woe-Tegbi-Dzelukope- Keta corridor. It has remained endemic at the Cape Saint Paul area in Woe. Losses are very low and the economic impact appears negligible. Only very few diseased palms were observed at the corridor during the last five surveys conducted between 1997 and 2008. A new outbreak was identified at Glidzi near Agbosome in 2006 with 9 infected palms. Thus, the presence of the disease since 1995 had been in few locations around the Keta lagoon with minimal losses. Less than 1% loss had been recorded of the estimated 1500 ha of coconut currently in the southern portion of the region.

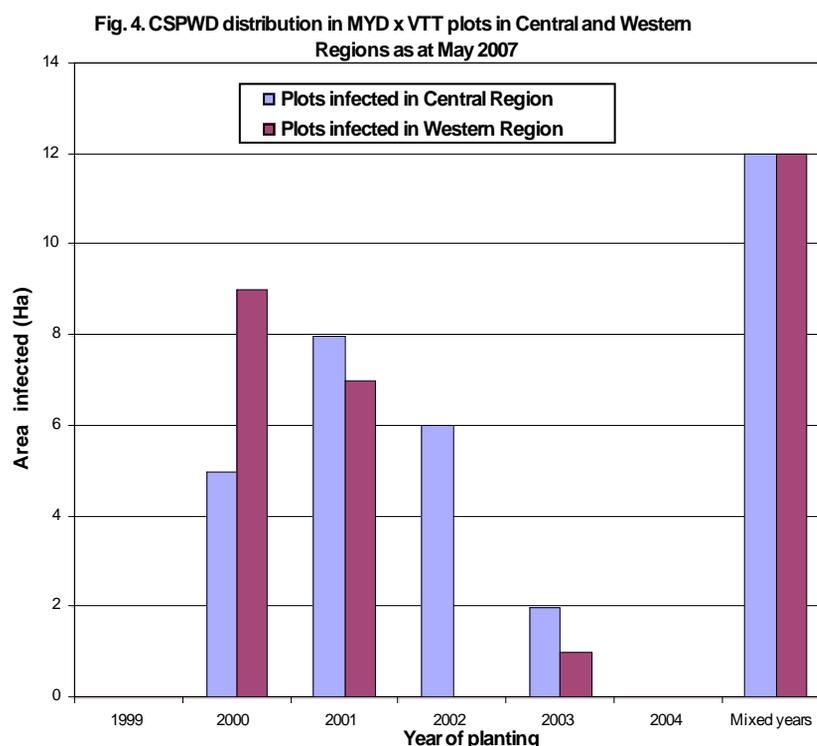


3.7. Disease management by removal of diseased palms

The CSPWD focus at Ampain is the western front of the disease zone along the coast. An estimated 3800 coconut palms covering an area of 25 hectares surrounded the main focus identified in 1995. 70% of the original stand has succumbed to the disease leaving about 30% (1130 palms) in existence as at March 2008. Of the percentage that was infected, 1331 palms were removed by cutting out through containment exercise undertaken since 1996. However, due to funding problems cutting was not done regularly through the period except 2003 – 2004 and from August 2007 to March 2008. Field observation shows a slow spread of the disease at this focus.

3.8. Disease spread in CSDP replanted plots

Between 1999 and 2004, 1300 hectares of devastated areas were replanted by CSDP with the MYD x VTT hybrid. About 1000 farmers were involved in the programme and had plot sizes of 1 – 3 ha in the Western and Central regions. 1288 hectares of these plantings monitored for CSPWD infection (929 and 359 hectares respectively in Western and Central regions), 62 hectares (4.8 %) (29 and 33 hectares respectively in the Western and Central regions) were observed and confirmed by PCR analysis to be infected by the disease. None of the plantings of 1999 covering 35 ha (22 in Western and 13 in Central) and 2004 covering 196 ha (176 in Western and 20 in Central) was as at May 2007 affected by the disease. When the programme began in 1999 planting sites were carefully selected by a site selection team unlike the subsequent years. The affected plots were mostly planted in 2000, 2001 and in the mixed year plantings. The disease incidence was slightly higher in the Central (33 ha) than in the Western region (29 ha) (Fig. 4).



4. Discussion

Coconut varieties in plantations in Ghana are mostly local WAT ecotypes. Their susceptibility to the CSPWD is very high. The pattern of the disease spread appears erratic occurring in ‘leaps’ or ‘jumps’ characteristic of insect transmission as in Caribbean LY disease (McCoy *et al*, 1983). However, some healthy palms can be observed even in heavily diseased farms.

The yellow patches in the ‘possible infection area’ (Fig. 1) observed in the aerial survey were not CSPWD. It is a known fact that most of the coconut palms in the south western part of the Western Region suffer from nutrient deficiencies, notably potassium, phosphorus and magnesium (Bonneau *et al*, 2002). Most of the palms in the area are almost senile. Both nutrient deficiency and senescence result in some yellowing of the crown of the palms. These phenomena, coupled with the high rate of lightning strikes prevalent in the area present an extensive area of yellowing coconut palms, a feature which could easily be mistaken for CSPWD.

The aerial surveillance provides a quick view of the coconut condition over a large area at a very short time. It is able to spot incipient foci as palms showing yellowing symptom singly or collectively can be spotted from the air and captured on GPS. This is dependent on the speed and height at which the aircraft travels. Captured data on GPS were detected within the radius of 300 metres on the ground. As indicated above, not

all palms showing yellowing symptoms are necessarily CSPWD infected. Thus, the method is not foolproof in identifying all CSPWD infections. To achieve that it has to be supported by ground surveillance to confirm disease infection. Another major drawback is that it is very expensive and cannot be done frequently without adequate resources. Aerial surveillance would be appropriate for early detection of incipient foci and half-yearly surveys are recommended for monitoring the large healthy zone lying west of Ampain.

The rate of spread of the disease at Ampain is slow. From field observations the estimated rate of spread per year of CSPWD is 0.33 km (about 1 km per 3 years). However, the spread around the disease focus at Ampain is less than 1 kilometre for the past 14 years. Comparatively, the Asanta focus which had similar features (*both foci established almost at the same time in coconut groves near swampy mangrove area, on outskirts of settlements less than 1 km to the coast, original coconut stands mainly of WAT subpopulations, dominant putative vector species encountered frequently at both sites were of the families of Derbidae, Cicadellidae, Diaspinae, Achilidae and Cixiidae*) except the periodic cutting (done once in 1994 at Asanta) had expanded more than 3 km to the east crossing the River Ankobra, 3.3 km to the west reaching Kikam and more than 4 km to the north. The slow spread at Ampain is attributed mainly to the containment exercise that has been undertaken at the focus since 1996. Although not rigorously practiced the containment exercise had slowed down the spread of the disease in this area. This agrees with the observations of Philippe *et al.* (2004) and Nkansah-Poku *et al.* (2005) that cutting out regularly all diseased palms slow down the rate of spread of the disease. Felling reduces accumulation of disease inocula in a given plot. Eradication must therefore be seen as part of an integrated control strategy of CSPWD. Its contribution will be to reduce the amount of inoculum present at any point in time for vector acquisition and transmission. A programme based on early detection and prompt removal of diseased palms to controlling disease spread is recommended to cover a wider area.

The behaviour of the disease in the south eastern portion of the country (Volta region) presents a unique situation. The disease disappeared after the major epidemic in the 60's and 70's and recurred in 1995. Since then its attack has been sporadic and less aggressive; and losses very low compare to that in the Western and Central regions. The low incidence may be attributed to the following field observed conditions. There is a relatively drier condition prevalent here. Coconut mainly grows in sandy dry soils around the Keta lagoon and the narrow coastal strip of land between the sea and the lagoon. Due to intense pressure on the land development of settlements under the plantations is a common feature; hence there is little ground cover. Flora diversity is low and insects' vector population and activity have been observed in the field to be sparse. Planting materials used for replanting the devastated fields after the epidemic have come from diverse sources and thus, presence of heterogeneous coconut subpopulations. These factors probably are influencing the variation in disease spread in the region. It would be interesting to begin comparative studies into the disease spread in the Volta and Western regions.

The disease attack on the MYD x VTT hybrid in replanted fields appears low for now. However, it revealed the susceptibility of the hybrid to high pressure of CSPWD as found on the fields in the Central region. In some fields palms were killed even before flowering. However, as suggested by Dery *et al* (2008) the hybrid MYD x VTT should be given the preference in areas where the risk of disease attack is very low due to its favourable agronomic performances and the fact that supplies of a superior hybrid are limited.

Acknowledgements

We are grateful to the Agence Francaise de Developpement (AFD), the French Embassy and the Government of Ghana for providing funds for the work. We acknowledge the services of Mr. Jonathan Porter, the pilot who flew the team safely.

References

- Bonneau, X, Dery, S. K and Andoh-Mensah, E (2002). CSDP Mission Report CP-SIC. 1497
- Dery, S. K, Philippe, R and Nkansah-Poku, J (1999). The history and epidemiology of CSPWD of coconut in Ghana. *Journal of the Ghana Science Association* Vol. 1 (2): 32-42.
- Dery, S.K, N'cho, Y.P, Sangare, A and Arkhurst, E.D (1997). Cape Saint Paul Wilt Disease: Resistance screening and prospects for rehabilitating the coconut industry in Ghana. In: Eden-Green, S.J. and Ofori, F (eds) (1997). *Proceedings of an International Workshop on Lethal Yellowing-Like Diseases of Coconut*, Elmina, Ghana, November 1995. Chatham, UK: NRI, pg 147-151
- Dery, S.K, Philippe, R, Baudouin, L, Quaicoe, R.N., Nkansah-Poku, J, Owusu-Nipah, J, Arthur, R, Dare, D, Yankey, N and Dollet, M (2008). Genetic diversity among coconut varieties for susceptibility to Cape Saint Paul Wilt Disease. *Euphytica* – *onlinefirst-DOI 10.1007/s10681-008-9691-8*.

- Johnson, C.G and Harries, H.C. (1976). A survey of Cape Saint Paul wilt of coconut in West Africa. *Ghana Journal of Agricultural Science*, 9: 125-129.
- Leather, R.L. (1959). Further investigation into Cape Saint Paul wilt of coconuts of Keta, Ghana. *Empire Journal of Experimental Agriculture*, 27:67-78.
- McCoy, R.E., Thomas, D.L and Condo, J.K. (1976). Lethal Yellowing: why the quarantine? *Nurseryman*, 21: 49-52.
- McCoy, R.E., Howard, F.W., Tsai, J.H., Donselman, H.M., Thomas, D.L., Basham, H.G., Atilano, R.A., Eskafi, F.M., Brit, L. and Collins, M.E.(1983). *Lethal Yellowing of Palms*. University of Florida Agricultural Experiment Stations Bulletin 834. Florida, U.S.A.
- Nkansah-Poku, J., Dery, S.K and Philippe, R. (2005). Reduction of spread of Cape Saint Paul wilt disease (CSPWD) of coconut by insecticidal hot-fogging and removal of diseased palms. *Ghana Journal of Agricultural Science NARS* edn 1: 193-198.
- Ofori, F and Nkansah-Poku, J. (1997). Cape Saint Paul wilt disease of coconut in Ghana: History of its occurrence and spread. In: Eden-Green, S.J. and Ofori, F (eds) (1997). *Proceedings of an International Workshop on Lethal Yellowing-Like Diseases of Coconut*, Elmina, Ghana, November 1995. Chatham, UK: NRI, pg 27-32.
- Philippe, R, Dery, S. K and Nkansah-Poku, J. (2004). New data on a cultural control method against coconut lethal yellowing in Ghana. *Cord* 2004, 20 (2): 21-27.