Reduction of spread of Cape St Paul wilt disease (CSPWD) of coconut by insecticidal hot-fogging and removal of diseased palms

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Abstract

A study was conducted to determine an effective method of reducing the spread of Cape St Paul Wilt disease of coconut. Hot-fogging with Diazinon and cutting out of diseased palms regularly (T1), hot-fogging with Chlorpyrifos and cutting out of diseased palms regularly (T2), and cutting out only were compared with the control, untreated check (TO). Hot-fogging with chlorpyrifos at 500 ml / 6.0 l of diesel per ha followed by cutting out all diseased palms was the most effective method. The apparent rate of spread of the disease declined by 48 per cent. Cumulative percent of diseased palms was below 30 per cent after about 2 years and population of suspected insect vectors was lower under this treatment compared to the untreated check. Predominant auchenorrhyncha caught in sticky traps were species of derbidae, *Myndus adiopodomumeensis* and *Nzinga palmivora*. The number of these species decreased considerably in the first 2 months following treatment by insecticidal hot-fogging. The results of the study showed that the spread of CSPWD in a field could be reduced by hot-fogging with chlorpyrifos and cutting out of diseased palms or cutting out alone of diseased palms promptly and regularly as they show initial symptom expression.

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Introduction

The Cape St Paul Wilt disease (CSPWD) is the most important disease of coconut in Ghana. Its spread poses a threat to the survival of the coconut industry in the country. The disease is a lethal-yellowing type disease (LYD) (Johnson & Harries, 1976) and is caused by phytoplasma (formerly mycoplasma-like organisms - MLOs) (Dabek, Johnson & Harries, 1976). CSPWD has been prevalent in Ghana since 1932 when it was first detected. Several thousands of hectares of coconut plantings in the Western, Central and Volta regions, the three main coconut producing areas in Ghana, have since been devastated by the disease and it is still spreading.

The capacity for rapid jump spread attributed to the insect vectors makes control of LYD difficult. In Ghana, the CSPWD jumped from Woe, spread to Cape Three Points in the Western Region in 1964 (Addison, 1972) and later to Ayensudo in the Central Region in 1983. Known vectors of phytoplasma diseases are species of leafhoppers and planthoppers (auchenorrhyncha) and psyllids (Tsai, 1976). A planthopper, *Myndus crudus* van Duzee (Homoptera: Cixiidae), had been shown to be the vector of LYD in Florida (Howard, Norris & Thomas, 1983). *Myndus taffini* Bonfils has been shown to be a vector of foliar decay of coconuts in Vanuatu (Julia, 1982).

Quarantine measures have had little impact in containing the disease. It has been pointed out that most secondary spread of the disease occurs within 100 m of a new focus and eradication could be useful if practised rigorously in the early stages of an outbreak (McCoy, Thomas & Condo, 1976). Frequent insecticide treatments were shown to reduce the rate of spread of lethal yellowing disease in sidewalk plantings of ornamental palms in Florida (Howard & Mc Coy, 1980). But such treatments are unlikely to be economical or environmentally desirable under the low input agricultural systems in which most coconut are grown in Ghana.

Efforts are being vigorously made to find a

resistant coconut ecotype/cultivar to the CSPWD. The rapid and destructive spread of the disease is creating problems in coconut-based industries in the country as the major factories cannot get raw materials. The disease devastation has a significant socio-economic impact on rural communities. Whole communities now find themselves without a sustainable livelihood. About 4.2 per cent of Ghana's population depends on coconut for their livelihood (Adam *et al.*, 1996). The devastation is also an environmental disaster. The shading and cooling effects of the palms and their aesthetic value especially along the beaches are lost. The disease spread has not been tackled by any meaningful control method since its inception. The need to protect the remaining coconut farms by containing the disease is, therefore, urgent.

Dery & Philippe (1997) observed that cutting out diseased palms combined with insecticide hot-fogging treatments might have slowed the spread of CSPWD in some disease foci in Ghana. This present study was to determine whether the method was indeed effective and the best insecticide to use.

Materials and methods

Eight isolated coconut farms were selected in a CSPWD outbreak area in the coastal belt of Komenda-Edina-Eguafo-Abrem and Cape Coast districts in the Central Region of Ghana. The farms, each of size approximately 2 ha had less than 5 per cent CSPWD infection (Table 1). The farms were within 15 km from the coastline. There was usually a close canopy no matter the plant spacing in all the farms selected. Vegetation was coastal savanna. Predominant weed species in all the fields were *Chromalaena odorata,* grasses, especially *Panicum maximum* and *Imperata indica,* and shrubs. These were in mixed stands and formed the main undergrowth of the farms and surrounding fields. All the farms were cropped with the local West Africa Tall coconut variety aged between 20-30 years. Maintenance of the farms was fairly good as they were cleared of weeds at least once a year. Other characteristics of the farms are shown in Table 1.

Treatments were assigned randomly as follows: Fields 4 and 7 = TO; 1 and 6 = Tl; 2 and 5 = T2 and 3 and 8 = T3. Two fields (To) were used as control and received no treatment. There was no hot-fogging and no cutting out of diseased trees in these farms. Tl was hot-fogged twice, one per month, with Diazinon 40 EC (Diazinon) at the rate of 500 ml / 6.0 l of diesel per ha and diseased trees cut out every month. T2 was treated as Tl but with Dursban 4E (Chlorpyrifos). On T3, there was no hot-fogging but all diseased palms were cut

TABLE 1

Characteristics of Farms Selected for the Study

Farm number.	*Age in years*	*Total plant population*	*Initial number of diseased trees*	*Initial disease infection (%)*	*Plant spacing*
I	20	300	9	3.0	Irregular
2	25	283	9	3.2	"
3	30	310	9	2.9	"
4	25	250	8	3.2	"
5	25	231	10	4.3	Regular
6	30	269	8	3.0	"
7	25	263	10	3.8	"
8	25	287	8	2.9	"

out every month.

Diseased and healthy palms were counted and tagged 4 weeks prior to the initiation of treatments and, thereafter, counting done every month for 20 consecutive months. This extended period of data collection was employed because coconut palms exposed to LYD do not develop symptoms until completing an incubation period of the phytoplasma (Dabek, 1975). Disease incidence was evaluated by examining each coconut palm for visible symptoms of CSPWD. Van der Plank's (1963) differential equation describing epidemic growth was used to determine the apparent rate of spread: $dx/dt = rx_t(1-x_t)$, where the change in proportion of disease, x, with time, t, is equal to a rate value, r, times the proportion of disease present at any time, x_t, multiplied by a factor (I-x) to account for the fact that the population under consideration is finite and cannot become more than 100 per cent infected. The apparent rate of spread, r, and *t*-test were used to compare the different treatments.

Auchenorrhynchous insects were sampled for 1 month before and 4 consecutive months after treatment application to determine their relative abundance, and how they would fluctuate in the different farms. This was done by hanging two yellow sticky traps (Dery, Philippe & Mariau, 1997) in the canopy of two healthy palms in each plot and inspected every other day.

Results

The progression of the disease under the various treatments is shown in Fig.1. The disease progressed slowly in the early months of the study in all treatments. It then rose rapidly in the untreated check (To) from the fifth month onwards whilst the rise in the treated farms was gradual. Mean cumulative loss of palms was 72.7 per cent of the original stand for the untreated check. This was twice as much as the loss recorded for T1 and T3, which were 35.5 and 36.2 per cent, respectively. T2 recorded the least mean cumulative loss of palms, 26.4 per cent, which was about a third of the loss that occurred on the untreated check. Table 2 shows the mean number

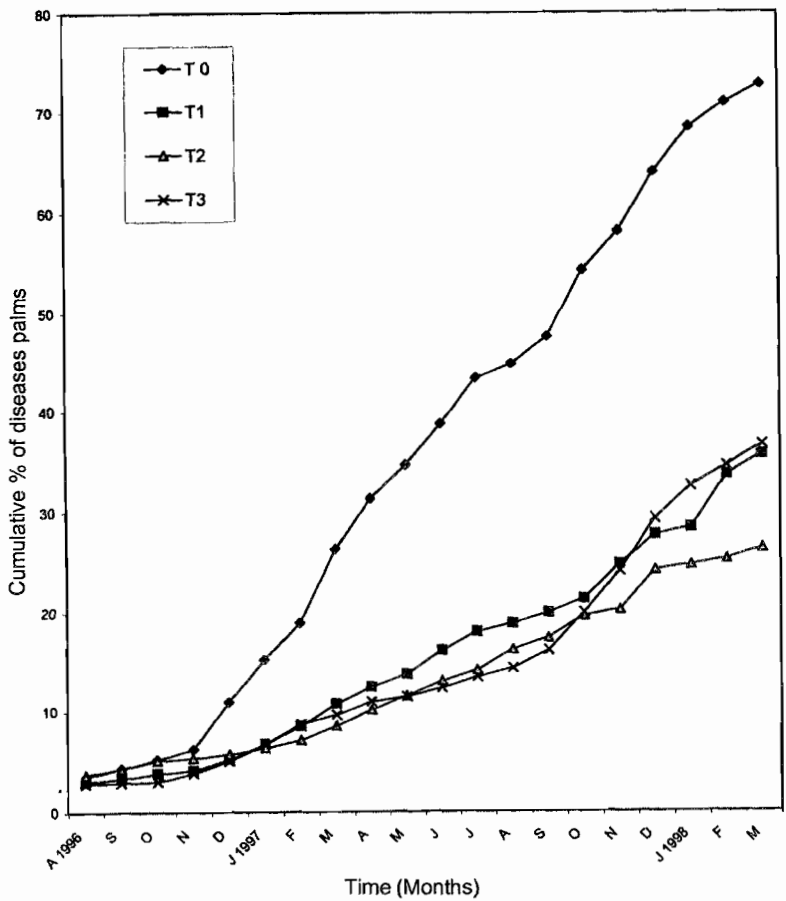

Fig. 1. Progression of CSPWD of coconut under different control treatment methods

TABLE 2

Effect of Treatment on Number of Palms infected by Cape St Paul Wilt Disease

Treatment method	*Means of infected palms*
T0	18.75a
T1	10.15b
T2	6.90b
T3	10.15b

Means with the same letter are not significant. Student's t-test at $P = 0.05$.

of palms infected monthly after treatment. More palms were infected on the control (T0) than the treated farms. There were no significant differences between treatments T1, T2 and T3 ($P = 0.05$).

Auchenorrhyncha caught in the sticky traps were predominantly species of derbids, *Nzinga palmivora* Wilson (Homoptera: Typhlocybinae) and *Myndus adiopodoumeensis* Synave (Homoptera: Cixiidae). Other homoptera species occurred infrequently. The average number of adults of the predominant species caught in traps on palms in treatments TI and T2 were lower than in T0 and T3 (Table 3). Population of auchenorrhyncha was reduced considerably in the first 2 months on T1 and T2, which received insecticidal hot fogging. This meant vector activities, mainly probing and feeding, which are normally involved in pathogen transmission might have reduced within the period.

Table 4 shows the apparent rates of spread of CSPWD calculated over a time span of 20 months. Apparent rate of spread, r, varied from 0.11 to 0.21 per unit per month (pupm). The rate was highest on the untreated field than the others. There was a 48, 33 and 10 per cent reduction in rate values of treated fields T2, Tl and T3, respectively, when compared to the untreated. This suggests that all the treatment methods under evaluation retard the advancement of the disease. However, the most effective method appeared to be T2, which had the least r-value of 0.11 pupm (Table 4).

Discussion

The results showed that hot-fogging followed by cutting out diseased palms, and cutting out diseased palms only, generally slowed down the spread of CSPWD. In farms that were treated in these way, lower percentages of diseased palms and low apparent rates of disease spread were recorded. The decreased rates of spread of the disease and the lower numbers of suspected insect vectors associated with insecticidal hot-fogging treatments suggested that leaf-feeding insects are involved in transmitting the CSPWD pathogen. The insecticidal hot-fogging probably reduced the average acquisition and or

TABLE 3

Number of Putative Vectors of CSPWD caught per Trap in Different Treatment Fields*

	Months after initiation of treatment						
Treatment method	*0*	*1*	*2*	*3*	*4*	*Mean*	*SD*
T0	6.0	6.5	5.5	6.0	9.5	6.7	1.6
Tl	8.0	1.5	0.5	5.5	6.0	4.3	3.2
T2	7.5	1.0	2.0	3.5	5.5	3.9	2.6
T3	9.0	8.0	12.5	8.5	7.5	9.1	1.9

* Include *Myndus adiopodoumeensis, Nzinga palmivora* and species of derbids. T0 = Untreated check, Tl = Hot-fogged with Diazinon + Cutting of diseased trees, T2 = Hot-fogged with Chlorpyrifos + Cutting of diseased trees, T3 = Cutting of diseased trees only.

TABLE 4

Apparent Rates of Spread (r) of CSPWD of Coconut in Different Treatment Fields

Treatment method	*r, units/month*	*Relative change in r of untreated check (T0) to other treatments*
T0	.21	
T1	.14	- 33 %
T2	.11	- 48 %
T3	.19	- 10 %

T0 = Untreated check, T1 = Hot-fogged with Diazinon + Cutting of diseased trees, T2 = Hot-fogged with Chlorpyrifos + Cutting of diseased trees, T3 = Cutting of diseased trees only.

inoculation access period or prevented potential vectors from completing their latent period in transmission of the disease pathogen. Cutting out diseased palms also reduced disease inoculum available to insect vectors present. Hence the chances of disease pathogen transmission were likely to reduce. The results are consistent with the results of experiments by Howard & McCoy (1980), where apparent rate of spread of lethal yellowing in Manila palms declined significantly in the diazinon and dimethoate treated plots but not in the untreated plots. They also recorded fewer auchenorrhyncha on treated compared to untreated plots.

The r value of 0.21 pupm recorded on the untreated check in this experiment is comparable with infection rates calculated for Kaincope disease in Togo (0.20) and lethal yellowing in Florida (0.21) by McCoy (1976). But it is much higher than those calculated by Schuilling, Kaiza & Mpunam (1992) for lethal disease in Tanzania (0.05-0.08) in young coconut plantings and (0.01-0.04) in mature stands. CSPWD is of recent evolution as compared to the lethal disease (LD), which has been in Tanzania for about a century (Schuilling, Kaiza & Mpunam, 1992). The East Africa Tall coconut variety might have developed some resistance/tolerance to the LD unlike the West Africa Tall variety to CSPWD. The similarity of the infection rates of lethal yellowing, Kaincope disease and CSPWD as revealed here in addition to the identical symptoms syndromes (Johnson & Harries, 1976; Dabek, Johnson & Harries, 1976) seemingly supports the view that these diseases may be co-identical. However, this is not so. Tymon, Jones & Eden-Green (1993) had shown that there are slight variations in the causative phytoplasmas of the Carribean (lethal yellowing), East Africa (lethal disease) and the West African (Kaincope and CSPWD) strains.

The number of replications (two per treatment) in the study was small. This was due to the fact that it was impossible to get and treat a larger number of fields with about the same disease percent infection and around the same time. However, the study provided substantial evidence that the spread of CSPWD slowed down appreciably with the treatments compared to the control.

Conclusion

From the study, hot-fogging with chlorpyrifos followed by cutting out all diseased palms emerged as the best treatment method in reducing CSPWD spread in the field. Cutting out regularly all diseased palms also showed reduction in the rate of CSPWD spread. However, it has been observed that for this to be more effective, the cutting should be done early (when only few trees are infected) before a disease focus takes hold. This could be achieved when scouting is done more frequently in the farm so that infected palms would be identified in their early stages of disease infection and removed promptly. This will be the most cost effective and environmentally sound method, which could be easily adopted by small-scale farmers.

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