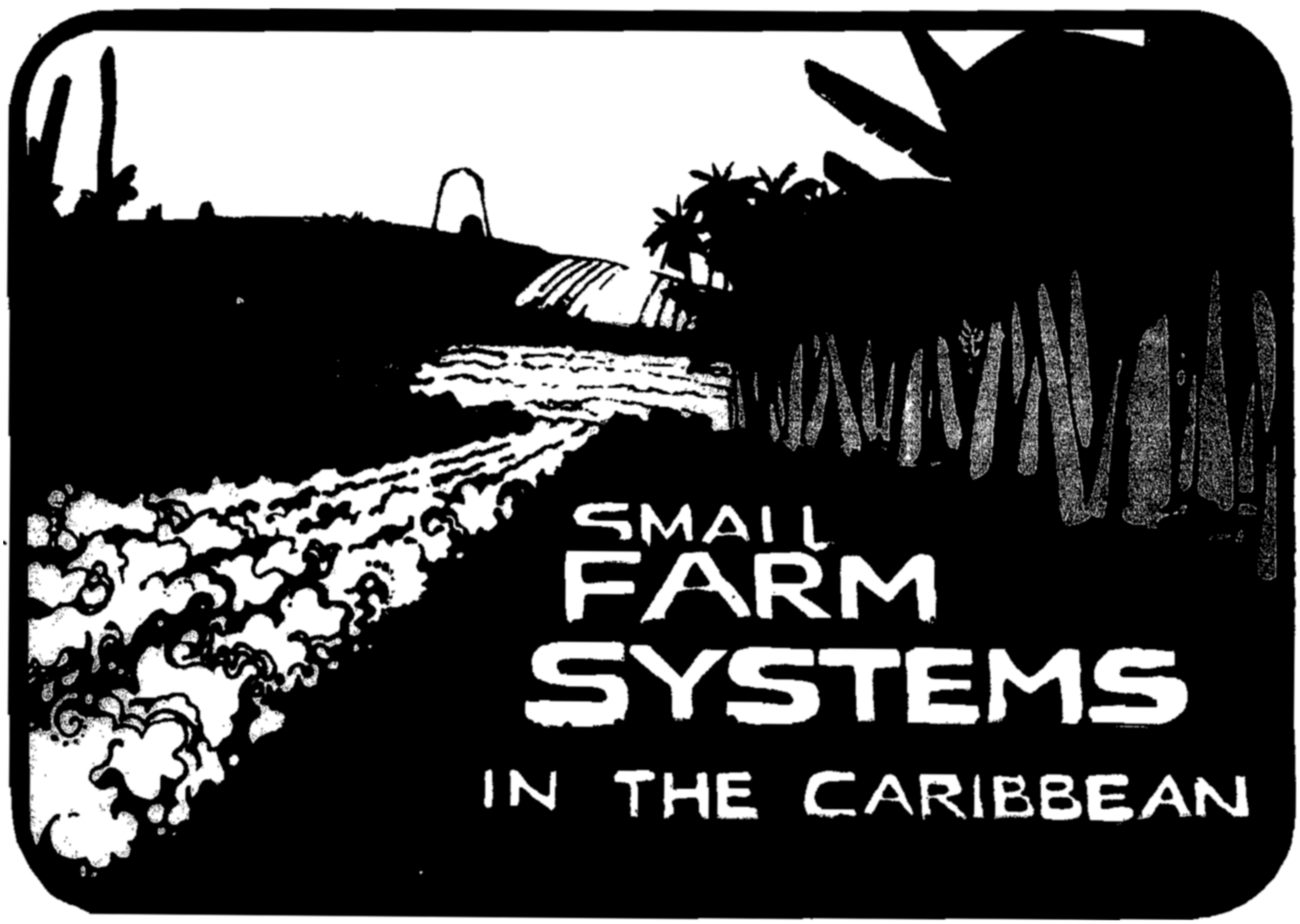
CARIBBEAN FOOD CROPS SOCIETY
Sociedad Caribeña de Cultivos Alimenticios
Association Caraïbe des Plantes Alimentaires

Vol. XX

PROCEEDINGS

OF THE 20th ANNUAL MEETING – ST. CROIX, U.S. VIRGIN ISLANDS – OCTOBER 21-26, 1984



Published by
THE EASTERN CARIBBEAN CENTER, COLLEGE OF THE VIRGIN ISLANDS *and* THE CARIBBEAN FOOD CROPS SOCIETY

Prospects for Control of the Vector of Lethal Yellowing on Small Coconut Farms

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Recent experimental evidence has implicated a planthopper, *Myndus crudus* Van Duzee, as the vector of lethal yellowing (LY). It may be inferred from experimental results that chemical control of LY would not be practical on small coconut farms. The fact that the immature forms of *M. crudus* utilize grasses as hosts may be a key to controlling this insect. The potential use of ground covers that are unattractive to *M. crudus* is discussed.

Keywords: *Myndus crudus*, palms, mycoplasma, *Cocus*, grasses. Suggested running head: Lethal yellowing vector control: Howard.

Lethal yellowing (LY) of palms is one of the most destructive diseases faced by tropical agriculturists. It is present in seven countries of the Caribbean and in parts of Africa. The impact of the disease was particularly severe in Jamaica during the 1960's and 1970's, during which period an estimated four million coconut palms were destroyed by the disease (Eden-Green, 1978), and devastating epidemics have occurred in Cuba, Florida, and most recently in Quintana Roo, Mexico.

Most of the world's coconuts are produced on small farms. Coconuts were listed among 20 major crops upon which a large portion of the human population depends (Mangelsdorf, 1966).

The disease is believed to be caused by mycoplasma-like organisms (MLO) since these are consistently found in phloem sieve tubes in diseased palms, but not in healthy palms (Beakbane, et al., 1972; Heinze et al., 1972; Parthasarthy, 1974; Plavsic-Banjac et al., 1972; Thomas, 1979; Thomas and Norris, 1980), and oxytetracycline treatments cause a remission of symptoms (Hunt et al., 1974; McCoy, 1972; McCoy and Gwin, 1977; Steiner, 1976).

Myndus crudus Van Duzee (Homoptera: Cixiidae) became suspect as a vector of LY when it was found to be the most abundant auchenorrhynchous insect on coconut palms in two LY-affected areas, *viz.* Jamaica (Schuiling, 1976) and Florida (Woodiel, 1976). In Florida, *M. crudus* was collected on all but the rarest LY-susceptible palm species (Howard and Mead, 1980) and was found to occur in higher numbers in the LY-affected areas than in LY-free areas (Howard, 1980). Insecticidal control of *M. crudus* reduced the apparent rate of spread of LY (Howard and McCoy, 1980). Replicated transmission experiments were conducted in which MLO were transmitted inside cages, apparently by *M. crudus*, to *Veitchia merrillii* (Becc.) H.E. Moore (Howard and Thomas, 1980), *Pritchardia thurstonii* F. Muell. & Drude and coconut palms (Howard, Norris and Thomas, 1983).

Two means of combating LY are the use of resistant palms (Harries, 1970; Harries and Romney, 1974; Shaw, 1971; Smith, 1970) and antibiotic treatments (McCoy and Gwin, 1977). This paper discusses the prospects for developing methods of controlling LY by controlling the insect vectors of the disease.

Chemical Control

In view of the evidence that *M. crudus* transmits LY, can insecticides applied to palms protect them from LY? There is little possibility that insecticidal control on small coconut farms would be practical and effective. In one experiment we sprayed foliage of Manila palms, *Veitchia merillii*, with insecticides biweekly for 15 months and carried out observations for 18 months (Howard and McCoy, 1980). The experiment compared treatments of dimethoate 400 at 2.6 ml/l, diazinon Ag 500 at 1.3 ml/l, and an untreated check. About 500 palms were in each treatment at the beginning of the experiment. Each treatment was divided into six replicates. Each replicate consisted of a 1.5 ha plot with 80-90 palms.

The incidence of LY was not significantly different in the three treatment areas during the first 12 months of spraying. We had anticipated this, because the incubation period (the time period between inoculation of the pathogen and expression of symptoms) of LY has been determined to be as long as 360 days (Dabek, 1975). Thus, in an area where LY is active it must be assumed that an unknown portion of the symptomless palms are actually infected. Spraying these palms cannot save them, but may help to protect uninfected palms by interrupting disease transmission. At the beginning of the experiment 12.9% of the Manila palms had LY symptoms. At the end of the first 12 months of spraying, losses of palms due to LY in the three treatment areas were as follows: dimethoate 64.2%, diazinon 49.1%, and untreated check 37.7%. There was no significant difference in disease incidence in the three treatments. It can thus be inferred that if a coconut farm manager were to discover that about 10% of his palms had LY symptoms, an intensive insecticide spray program might make no impact during the first year.

We compared the apparent rate of spread in different treatments during the 12th to the 18th month of the experiment. Any differences in the rates of disease spread in the different treatments would probably be related for the most part to treatments applied during the first 12 months of the experiment. We found that the rate of spread (based on symptoms) rose in the untreated check and declined in the two insecticide treatments ($P < 0.05$). Losses of palms in the different treatments during the latter 6-month period were as follows: dimethoate 23.4%, diazinon 29.4%, and untreated check 46.6%. Although the results show that insect control can reduce the rate of spread of LY, losses of palms in treated areas were unacceptably high.

Since *Myndus crudus* adults are highly active flying insects, it would be difficult to maintain continuous protection of palms with insecticides alone. Modifications of the described spray program that could result in more effective protection of palms might include more frequent spraying, higher dosages of the insecticides or more toxic or more persistent insecticides, spraying of alternate hosts of the vector, and treatment of larger areas. Also, more effective protection of a palm planting could be provided if a spray program were started prior to the initial infection of the planting. Incorporating all of these modifications, a hypothetical 2 ha coconut farm threatened by LY could be protected by beginning weekly or perhaps daily applications of a highly toxic and persistent insecticide to all palms and herbaceous plants within a kilometer or so of the farm. The program would be continued until there were no more cases of LY in the province—perhaps a period of 100 years!

As more is learned concerning the disease cycle of LY, the life history and behavior of *M. crudus* and as improvements are made in insecticides and application methods, chemical control of the vector of LY may become feasible. For now, it does not seem promising.

Control by Natural Enemies

In Florida, we have identified a number of natural enemies of *M. crudus*, including spiders of several specides (Howard and Edwards, 1984), ants, lizards, and three frogs. A fungus, *Hirsutella citriformis* Speare and parasitic mites, *Leptus* sp. and *Erythaeus* sp. are occasionally found on *M. crudus*. These natural enemies occur in LY-affected areas. Thus, under our conditions they have been ineffective in preventing the spread of the disease. *Myndus crudus* is regarded as native to the neotropics and is distributed from the extreme southern United States through northern South America (Kramer, 1979; Meyerdirk and Hart, 1982). Possibly, effective natural enemies may be present somewhere within this geographical area.

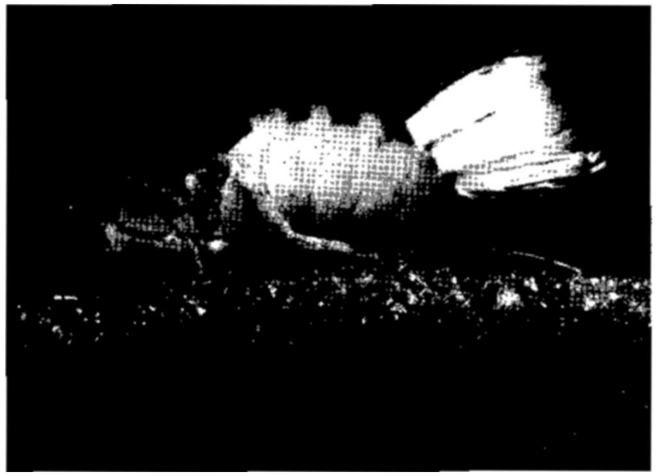
Cultural Control and Host Plant Resistance

Considering the large number of palm species visited by *M. crudus* (Howard and Mead, 1980) and the abundance of these insects on several varieties of coconut palm in Florida, it seems doubtful that varieties of coconut can be found that are not attractive to this insect. Still, the host plant relationships of *M. crudus* are known superficially at best. A coconut palm variety that is resistant to this insect may one day be discovered.

At the present, we are focusing our attention on the grass hosts of *M. crudus*. The females of this insect lay their eggs on grasses, and the nymphs develop in the root zones (Fig. 1). Adults are found on grasses and on palms (Tsai and Kirsch, 1978; Zenner de Polania and Lopez, 1977). We have examined roots of many palms without finding *M. crudus*. Assuming that grasses are a vital link in the life cycle of *M. crudus*, it is theoretically possible to eliminate this insect from an area by eliminating its grass hosts.

Grass or other ground cover is desirable in a coconut planting for erosion control or where cattle are reared on the same farm.

FIGURE 1: ***Myndus crudus*** **nymph on stolon of St. Augustine grass.**



Also, keeping a farm and its adjacent areas free of herbaceous vegetation would be overly costly.

Progress has been made in developing ground cover management methods that reduce the infestation of peach orchards by leafhopper vectors (McClure et al., 1982). This approach should be investigated as a possible means of controlling LY.

Eden-Green (1978) reported that St. Augustine grass, *Stenotaphrum secundatum* (Walt.) Kuntze, was the most reliable grass for rearing *M. crudus* for experiments. Reinert (1980) reported that higher numbers of adults were collected in sweep net samples from St. Augustine grass than from Bermuda grass, *Cynodon dactylon* Persoon, or Bahia grass, *Paspalum notatum* Fluegge. In Florida, high incidence of LY coincides both with high populations of *M. crudus* and extensive use of St. Augustine grass as a turf (Howard, 1980).

It is thus disconcerting that St. Augustine grass is recommended in islands of the Pacific as a forage grass compatible with the coconut-cattle farming system (Smith and Whiteman, 1983). The extensive use of St. Augustine grass on coconut farms should be avoided since this could increase the risk of an LY epidemic should this disease be introduced. But we don't yet know which other grasses or dicotyledenous plants would reduce this risk.

A more complete knowledge of the host plant relationships of *M. crudus* nymphs is needed. Can a grass be found that is tolerant of the shade of coconut canopies, that is unacceptable as a host of *M. crudus*, and aggressive in competing with grasses that do serve as hosts? Leguminous and other dicotyledenous ground covers should also be invesrigated, since they are unlikely to serve as hosts of *M. crudus*.

In addition, we need to develop knowledge of the flight behavior of *M. crudus*. The minimum area over which ground cover management must be practiced in order to be effective in controlling LY would be determined largely by the distances that adult *M. crudus* fly from their nymphal hosts to palms.

Most insect-vectored plant diseases are not successfully controlled by controlling the vector. Nevertheless, the possibility of controlling LY by management of the nymphal hosts of *M. crudus* seems promising, and warrants research efforts.

Acknowledgements

I thank Mr. J.V. DeFilippis, Agricultural Research Technician, for providing Fig. 1, and Dr. Ted Center, U.S. Department of Agriculture, for reviewing the manuscript.

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