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PREVENTION OF LETHAL YELLOWING IN THE EASTERN CARIBBEAN

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ABSTRACT

Lethal yellowing (LY) is a fast-spreading disease which destroys coconut and other palms. Once limited to the Greater Antilles except for Puerto Rico, it has crossed ocean barriers of 145 km or greater to invade new areas and thus should be considered a threat to Puerto Rico and the Lesser Antilles. The American palm cixiid (Myndus crudus Van Duzee), which is the known vector of LY, has not been reported in Puerto Rico nor in the Lesser Antilles north of Trinidad. Otherwise, environmental conditions appear to be conducive to the spread of LY, were it introduced into these islands. Principles and techniques which could lessen the risk of introduction and spread of LY in the eastern Caribbean are discussed.

INTRODUCTION

Lethal yellowing (LY) is a disease of palms known for its fast rate of spread and its rapid lethal effect. More than 30 species of palms are susceptible, including the economically important coconut palm (Cocos nucifera L.) and date palm (Phoenix dactylifera L.) (Thomas, 1979; Thomas and Norris, 1981; Table 1). Studies indicate that the disease is caused by mycoplasma-like organisms (MLO), which are transmitted by a species of planthopper, the American palm cixiid, Myndus crudus Van Duzee (Homoptera: Cixiidae as reviewed by Howard, 1987). Available evidence suggests that the American palm cixiid is the principal, if not sole vector of LY in the Caribbean Region (Howard and Barrant, 1989).

The Spread of LY in the Americas

The following is a synthesis of an earlier review (Howard, 1983), supplemented by more recent observations by the author and current information on LY in Mexico from the Fats, Oils, Soaps and Detergents National Chamber, Mexico City: LY has probably affected coconut palms in the Greater Antilles except Puerto Rico for at least 150 years. Since the late 1800's, the disease has repeatedly ranged over Cuba and spread throughout Jamaica. The most recent outbreak in the Dominican Republic was on the north coast in the late 1960's.

LY was probably introduced into Key West, Florida, from Cuba. These islands are about 145 km apart at their closest points. In 1969, LY was first observed on Key Largo, 160 km from Key West. In 1971, LY was first observed in Miami on the Florida Mainland, and within 2 years cases were observed 100 km north in Palm Palm Beach County. In 1987, LY broke out on the west coast of Florida, about 200 km across the peninsula from West Palm Beach.

There is evidence that LY was present on New Providence in the Bahamas, which is about 450 km from both Cuba and from Florida, as early as the 1920's. Several cases were diagnosed there in the 1970's. We have recently received unconfirmed reports of cases on Spanish Key near the Abaco Islands in the Bahamas.

In the late 1970's LY was first observed in southern Texas [destroying date palms (Phoenix spp.) - coconut palms do not grow in Texas] and on the eastern tip of the Yucatán Peninsula, Mexico. In Mexico, LY has spread south and west in Quintana Roo, killing 70% of the coconut palms in that state, is spreading westward in Yucatán at about 2 to 5 km per month, and has killed coconut palms in Campeche and Tabasco. Further spread along the Atlantic Coast of Mexico and Central America appears imminent.

Modes of Introduction of LY

LY could be introduced into the Eastern Caribbean by introduction of either a living plant infected with the MLO's that cause the disease, or an insect vector infected with this agent.

MLO's have been observed in the phloem sieve tubes of palms with symptoms of LY. They have not been observed in asymptomatic palms, but since LY has an incubation period of a few to many months (Dabek, 1975), it follows that palms harbor MLO's prior to developing symptoms. Thus, it may be assumed that LY could be introduced with any palm of a species susceptible to LY, even though the individual palm appears to be healthy. There is a great deal about LY remaining to be discovered, including whether non-susceptible plant species serve as symptomless hosts. The question of whether LY could be introduced via seeds of susceptible palms is controversial, but plant pathologists generally agree that MLO's are not transmitted via seeds. In summary, the most likely mode of introduction of LY in an infected plant would be in a palm of a susceptible species.

Nymphs of the American palm cixiid develop in the root zones of certain species of grasses (Eden-Green, 1978). Hosts of adults apparently include many species of palms (Howard and Mead, 1980) and probably grasses.

Infected insect vectors are probably introduced into new regions either aboard host plants, or carried by air currents. Host plants harboring insect vectors could include palms with adult planthoppers or turf grass sod harboring planthopper nymphs in the root zones.

LY has never been reported in Puerto Rico or the Lesser Antilles. From their geographical position, however, the islands of the eastern Caribbean are vulnerable to the introduction of this disease. Puerto Rico and Hispaniola are about 175 km apart at their closest points, and most of the islands of the Lesser Antilles are 100 km or less apart. We have already seen that LY has crossed greater barriers.

In order for the disease to spread in a new area, there would have to be (1) susceptible hosts, and (2) a population of insects capable of transmitting the disease agent.

The most common tall coconut palm variety in Puerto Rico and on most islands of the Lesser Antilles is the 'Jamaica Tall'. It is probably virtually 100% susceptible to LY (Harries, 1971, 1977). Exotic palm species, many of which are susceptible to LY, are planted as ornamentals in many of the resort areas. Thus, one condition for the establishment of LY on these islands is met.

It is doubtful that a second condition is met, i.e., the presence of a vector population. The only species thus far implicated as a vector, the American palm cixiid, is known in southern Florida, from southern Texas to northern South America and on four islands of the Caribbean: Cuba, Jamaica, Grand Cayman and Trinidad (Howard, 1983 and references cited). A closely related species, but not the American palm cixiid, was found on palms in the Dominican Republic, and may possibly be the vector of LY in Hispaniola (Howard et al., 1981). There are no records of the American palm cixiid in Puerto Rico, where the Auchenorrhyncha are well known (Ramos, 1988), nor on islands of the Lesser Antilles north of Trinidad.

However, the American palm cixiid or some other species capable of transmitting LY could become established. Likewise, it is conceivable that an as yet unidentified vector already present on these islands could be capable of transmitting the disease. A successful invasion of Puerto Rico and the Lesser Antilles by the American palm cixiid would depend on suitable environmental conditions for this insect, particularly the presence of grasses that could serve as breeding hosts of the insects. St. Augustine grass [Stenotaphrum secundatum (Walt.) Kuntze], the most common lawn grass in southeastern Florida, is a highly favorable breeding host of this insect, and may have contributed to the LY epidemic in that area by supporting relatively dense vector populations (Howard, 1980, 1990b).

Guinea grass (Panicum maximum Jacquin), also a highly favorable breeding host (Howard, 1990c), may have played a similar role in Jamaica, where it is one of the most common grasses in the coconut growing areas. 'Puerto Rico' star grass (Cynodon nlemfluensis Vander var. nlemfluensis) is a highly favorable breeding host of the American palm cixiid (Howard, 1990a), and is very common in coastal areas of Puerto Rico (Dr. Antonio Sotomayor-Rios, USDA, Mayaguez, P.R., personal communications) as are star grasses in general in the Caribbean. Additional grasses and their roles as breeding hosts of the American palm cixiid were reported by Howard (1990a,b,c). It thus appears probable that if the American palm cixiid were introduced into Puerto Rico or the Lesser Antilles (males and females, or one fertilized female), it could become established.

Observations have suggested that LY spreads more rapidly on golf courses and other high maintenance areas than on poorly maintained sites or ocean beaches (McCoy, 1975). On the southeast coast of Florida, 'Jamaica Tall' coconut palms on the major beaches (e.g., Ft. Lauderdale, Haulover, Lummus Park beaches) have rarely been affected by LY (Howard, 1990a), probably either because of the physiological condition of the palms at such sites, adverse ecological conditions for insect vectors, or a combination of these.

LY Prevention in the Eastern Caribbean

Regulations should prohibit entry of any plant species known to be capable of harboring LY pathogens, i.e., all susceptible species of palms (Table 1) originating from LY-affected areas.

In addition, the entry of grasses and palms from LY-affected areas, because they could serve as hosts of the American palm cixiid, should be regulated, i.e., either inspected, treated, or prohibited.

The above procedures represent minimum preventive measures. Additional measures might include the prohibition of all palm species (not just proven susceptible species) from LY-affected areas, since it is conceivable that as yet unidentified symptomless hosts might harbor the LY agent; and a ban on entry of seed of LY hosts. Even the most extreme regulatory measures imaginable (e.g., prohibition of all living plant material from any tropical area), the practicality of which would be highly questionable, would not eliminate risk, particularly the risk of introduction by natural means (e.g., infected vectors on air currents.)

TABLE 1. List of palm taxa susceptible to LY in Florida, their native homes, and relative susceptibility to LY.

Palm taxon	Native Home	Relative Susceptibility
Aiphanes lindeniana H. Wendl.	Colombia	*
Allagoptera arenaria (Gomes)	Brazil	*
Arenga engleri Beccari	Taiwan	3
Syagrus schizophylla (Martius)	Brazil	2
Borassus flabellifer L.	India	2
Caryota mitis Loureiro	Malaya	2
Chrysalidocarpus cabadae H. E. Moore	cultivated	1
Cocos nucifera L.	SW Pacific	3
Corypha elata Roxburg	India	3
Dictyosperma album (Bory)	Madagascar	2
Gaussia attenuata (O. F. Cook)	Puerto Rico	*
Howea belmoreana Beccari	New Zealand	*
Hyophorbe vercheffeltii H. Wendl.	Madagascar	2
Latania spp.	Madagascar	2
Livistona chinensis (Jacquin)	China	1
Nannorrops ritchiana (Griff.)	Afghanistan	*
Neodypsis decaryi Jumelle	Madagascar	1
Phoenix canariensis Hort. ex Chabaud	Canary Isls.	2
Phoenix dactylifera L.	N. Africa	3
Phoenix reclinata Jacquin	W. Africa	1
Phoenix rupicola T. Anders.	India	*
Phoenix sylvestris Roxburg	India	*
Pritchardia spp.	Pacific Isls.	3
Ravenea hildegrandtii Bouche	Madagascar	*
Trachycarpus forntunei (W.J. Hooker)	China	2
Veitchia merrillii (Beccari)	Philippines	2
Veitchia arecina Beccari	New Caledonia	*
Veitchia montgomeryana H. E. Moore	New Hebrides(?)	*
Veitchia sp.		*

(Susceptibility ratings based on combined observations of Fort Lauderdale Research & Education Center personnel. 1 = slightly susceptible; 2 = moderately susceptible; 3 = highly susceptible. * = unknown susceptibility).

Environmental Management to Prevent or Reduce the Spread of LY

Table 2 illustrates the environmental conditions that would be expected to influence the establishment and spread of LY in a new area.

Tres Hermanos Beach (Figure 1) near Mayaguez, may be mentioned as a fairly typical site for coconut palms in Puerto Rico and the Caribbean. Four factors associated with the coconut stand at Tres Hermanos Beach are conducive to vulnerability to LY: (1) as elsewhere in the Caribbean, the coconut palms on this beach are apparently of the highly susceptible 'Jamaica Tall' variety; (2) these palms are planted together in a monoculture of a few thousand palms; (3) the palms are unusually tall; and (4) not shaded by a canopy of taller trees. Although the planting is apparently not under high maintenance, it receives abundant water: rainfall, based on 1987 measurements (Howard et al., 1990), is well distributed except for winter months and is about 200 cm per year. Whether this affects the susceptibility of palms is unknown. At the least, it probably results in favorable conditions year-round for the development of insect vectors.

Fig. 1. 'Caribbean Tall' coconuts at Tres Hermanos Beach, P. R.

Table 2. Factors known or suspected to influence the rate of spread of lethal yellowing disease of coconut palms. (sources: Howard 1990a, Howard et al., 1979, 1987, McCoy 1975, 1976).

Environmental Condition	Rate of Spread of LY	
	Rapid	slow
Palm species, varieties	susceptible	resistant
Palm planting density	high	low
Palm planting diversity	low, restricted to susceptible species	high, includes resistant species
Age/height of palms	old/tall	young/short
Exposure of palms	in full sun	shaded
Abundance of breeding hosts of insect vector	abundant	rare
Maintenance practices (fertilizers, irrigation, etc.)	intense	lax

Table 3. Grasses that have been experimentally shown to be poor breeding hosts of the American palm cixiid.

Axonopus sp. (Carpet grass)
Brachiaria brizantha Hochst. ex A. Rich. (palisade grass)
B. dictyoneura (Fig. & DeNot) Stapf.
B. humidicola (Rendle) Schwenk (kornivia)
Chloris gayana Kunthe (Rhodes grass)
Hemarthria altissima (Poir.) Stapf. & C. E. Hubb. (limpo grass)
Hyparrhenia rufa (Nees.) Stapf. (puntero)
Pennisetum purpureum Schumacher (dwarf napier grass, Tifton N75)

On the other hand, the as yet undefined factors associated with beaches referred to above could curtail the spread of LY at Tres Hermanos.

The defenses against LY could be tightened at Tres Hermanos Beach by interplanting the existing stand of coconut palms with resistant varieties or hybrids. Interplanting with young palms probably needs to be done anyway. Lightning strikes, wind-throw, etc., may begin to thin out this apparently 80- to 100-year-old stand.

Where appropriate to the landscape design, interplantings and new plantings of palms should incorporate diverse species and involve a maximum of palms of resistant species or varieties. Of 127 palms native to the Caribbean Region that were exposed to LY in Fairchild Tropical Garden, Florida, only the "palma de lluvia", Gaussia attenuata (O.F. Cook) Beccari, native to Puerto Rico, was susceptible to LY (Howard et al., 1979). No native palms have been reported to be susceptible to the disease in LY-affected areas of Cuba, Jamaica, Hispaniola nor Florida. Thus for some landscapes, a mixture including native Caribbean species of such genera as Acrocomia, Coccothrinax, Copernicia, Pseudophoenix, Roystonea, Sabal, and Thrinax, is recommendable (Howard and Collins, 1978).

However, as a crop tree and in many landscape situations, no palm can substitute the coconut palm. Three varieties, the 'Red (=Golden) Malayan Dwarf', the 'Green Malayan Dwarf', and the 'Yellow Malayan Dwarf' were identified as resistant to LY several decades ago. Millions of these Malayan dwarf varieties have been planted in Jamaica, and tens of thousands in Florida. Although LY killed a high proportion of these palms on several very limited sites in both countries (Howard et al., 1987), in general they are more than 90% resistant to LY. They have desirable characteristics as crop trees (Harries, 1970), and are excellent ornamentals. An adverse feature is that, based on our experience in Florida, they are poorly adapted for landscaping beaches. In such situations, they tend to become stunted, with pronounced trunk taper, and often exhibit leaf burn.

The 'Maypan', which is a hybrid between the 'Malayan Dwarf' and the 'Panama Tall' coconut palm has a reputation for greater adaptability than Malayan dwarf varieties and may be more recommendable for beach areas. Additional varieties and hybrids of the coconut palm are being sought and tested in Florida and Jamaica.

Ground cover management would offer an additional means of protecting plantings from LY. Several grass species have been found to be poor breeding hosts of the American palm cixiid under experimental conditions, and additional grasses are being tested (Table 3; Howard, 1990a,b,c). Dicotyledonous plants apparently do not serve as breeding hosts of this insect (Howard

et al., 1984), thus several species are being investigated as potential ground cover under coconut palms. Tropical forage legumes (Targas et al., 1990) might be especially suitable.

LY remains a poorly understood disease. Nevertheless, the risks of introduction and establishment of this disease in the eastern Caribbean can be lessened by applying the principles and techniques discussed in this paper.

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