Doenças do tipo amarelecimento letal do coqueiro e outras palmeiras: ameaças para Arecaceae

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Global Village and Globalization. Consequences.

In a few years we have moved from the concept of the "global village" from Mc Luhan (1967), to that of "globalization", in the 2000s. In the 60s the globe became contracted by electronic technology and the instantaneous movement of information in all directions. Today, people, animals, plants, commodities, can move from one continent to another continent in a few hours. Pest and pathogens too! In 2002, SARS (Severe Acute respiratory Syndrome) traveled by plane from Hong Kong to Toronto in less than 48 h. In the mid-1990s, the butterfly *Paysandisia archon* arrived in France with imported palms from Argentina and the larva is now killing several palm species in southern Europe. In 2013, the bacteria *Xylella* was introduced in Italy with importation of coffee plants from Costa Rica and it is now destroying olive groves containing centuries old olive trees! A possible future disaster for all related economy with olives in Europe.

Brazil under the pressure of the Caribbean.

With this globalization, Brazil and Latin America, like other countries, are exposed to risks from anywhere in the world, but particularly from infectious events occurring in the Caribbean. The red palm mite, *Raoiella indica* – originating from India- is a good example of the risks from the Caribbean. From 2004 onwards it started to be a problem in Martinique and the following years, it has spread over several other Caribbean Islands, before landing in Brazil in 2009. In December 2013 the human disease Chikungunya was diagnosed in Saint Martin. One year later it was in French Guyana, and now the disease in endemic in Amapa and Bahia.

Today, a significant risk must be taken seriously because its socio-economic consequences are very important: the Coconut Lethal Yellowing (LY).

The coconut lethal yellowing.

Coconut Lethal Yellowing (LY) was rife in the 1800s, in a region including the Cayman Islands, Jamaica and Haiti. Since then, LY spread in Florida in the 60-70s. Only almost than two centuries after the first report, it was detected in the Yucatan peninsula of Mexico at the very beginning of the 1980s. Then, there has been an acceleration of disease propagation. In 1996 it was recorded in Honduras. In 2006 the south of the Dominican Republic and Nevis were affected. In Puerto Rico LY was reported in 2010. In 2012/2013, the LY was diagnosed in Antigua, Saint Martin/Sint-Maarten, Saint Barthélémy and the vector was identified in La Guadeloupe. In most cases, from 1980 to 2013 the disease has been introduced in new areas by humans (unintentionally).

LY is a very fast spreading disease and is highly destructive. It kills a coconut tree or other palms in the space of 3 to 6 months. When the disease arrives into a coconut plantation, whatever its size, all the coconuts trees die in one to two years. LY has killed millions of plants in the Caribbean over the past 50 years.

Host range of LY.

Coconut tree is not the only one affected by LY in the Caribbean. There are about 40 species of palms that can be killed by this disease. Among these susceptible palms we find several ornamental palms like *Adonidia merrillii, Pritchardia pacifica*, *Roystonea spp*., *Syagrus schizophylla, Washingtonia robusta* etc. But some susceptible species are important cultivated crops like *Phoenix dactylifera.* This means that the LY is not only a threat for coconut palms, but also for all other palm species already reported as susceptible to LY and perhaps for several native palms to the Amazon.

The Lethal Yellowing Type Syndromes (LYTS).

At the beginning of the 20th century, the same type of disease was observed on coconut palms in in East Africa, in Tanzania, where it is called "Lethal Decline Tanzania" (LDT). In West Africa, several diseases with local names were reported in the 1930s: "maladie de Kaincopé" au Togo, "Cape Saint Paul Wilt" in Ghana, Akwa disease in Nigeria "maladie de Kribi" in Cameroon. A disease called "lethal yellowing" began making extensive damage in Mozambique in the 1990s, but it is possible that it was present in the north of this country not long after Tanzania became affected. The travel from West or East Africa (where several LYTS exist) to Brazil, can be done in less the 24 h. So, do not overlook the risk coming from Africa.

In the Caribbean islands, in Florida, in Central America and in Africa, all these diseases show a very similar syndrome. Indeed, one has to refer to a syndrome to describe these diseases that can be called "Lethal Yellowing Type Syndromes" and not to a single symptom. As a matter of fact, seeing a coconut palm with yellow leaves during a one-off survey does not necessarily mean LY. Many mineral deficiencies can provoke a yellowing of the leaves. Likewise, the presence of coconut trunks that have lost all their leaves can have various causes like lightning, insect damage or other diseases. For instance, it should be known that two other coconut diseases, Hartrot caused by a trypanosomatid – *Phytomonas sp*. – and Red Ring, caused by the nematode *Bursinaphelencus cocophilus* Cobb. can be confused with LYTS, even after observation of the syndrome. Like many other monocots, the coconut palm only displays a limited number of symptoms in response to biotic and abiotic stresses

Symptomatology of the LYTS.

In every LYTS, the first symptom is the nuts to fall, both ripe and unripe. The presence of nuts of all ages below a coconut palm is the first alarm signal. Then the leaflets at the tip of a lower frond turn yellow. At this stage, a blackening – necrosis – can be seen on the rachillas of the most recently opened inflorescence.

If the next inflorescence still wrapped in its spathe (younger) is collected and opened, browning can be seen on some or all of the male flowers, and on the tips of the rachillas themselves. The yellowing progresses on leaves younger and younger. The yellow fronds then turn brown, dry out, hang down the stem, and fall.

Rotting of the spear leaves occurs more or less rapidly, before the yellowing reaches the youngest fronds. Finally, only the trunk remains, terminating in five to six young yellow small leaves and this "tuft" eventually snaps due to the gradual spreading of the rot throughout the meristematic zone. Infected palms usually die within 3 to 6 months after the appearance of the very first symptom. It should be noted that the Hartrot syndrome exhibits the same syndrome. The reason probably lies in the fact that these two diseases are caused by intraphloemic microorganisms.

Others phytoplasmas diseases.

There several reports of phytoplasmas associated with coconuts showing some "disorders" or diseases with occurrence of yellow leaves in Asia. In Indonesia, such diseases exist on the island of Natuna (Natuna wilt) and in Kalimantan (Kalimantan wilt). However, the phytoplasmas identified in these diseased trees do not belong to the 16S rDNA groups of the Caribbean or the groups present in Africa. In Papua New Guinea a new phytoplasma was identified in coconuts affected by a new disease called "Bogia syndrome" in 2013.

Transmission.

Haplaxius (Myndus) crudus – Cixiidae – was found to be a vector of LY vector in Florida and in Mexico. But other insects could be involved *like Nymphocixia cairbbea*, other cixiid, in Cuba and Jamaica. Nothing is known about the vector(s) of the LYTS in Africa.

Variability, diversity, of the Phytoplasmas.

Phytoplasmas (ex. Mycoplasma Like Organisms- MLO) are specifically associated with various LYTS. They were firstly discovered by electron microscopy. As phytoplasmas cannot currently be grown *in vitro*, it is impossible to demonstrate their etiological role based on Koch's postulates. However, the remission of some diseased palms has been obtained after treatments with tetracycline, which supports the pathological role of phytoplasmas. Today PCR has replaced lengthy microscopy for the diagnosis. The target gene to be amplified by PCR is that of ribosomal RNA (rRNA). Analysis of the PCR products by restriction fragment length polymorphism (RFLP) has led to the delimitation of around 35 "groups" – 16s rDNA – of phytoplasmas and most of the groups contain subgroups.

The phytoplasmas associated with LY in the Caribbean belong to group 16S r DNA IV. This group IV contains 4 or 5 subgroups. The phytoplasmas, associated with the LYTS in West Africa and in Mozambique form the group XXII. The phytoplasmas from Tanzania (LDT) form another specific group, including several subgroups, to be created.

Variability for resistance/susceptibility.

The diversity and variability of the phytopasmas associated with the different LYTS is also reflected in the resistance or susceptibility of coconut varieties. For instance, in the 1960/1970s, the Malayan Yellow Dwarf (MYD) displayed some level of resistance to LY in Jamaica and Florida. But in Ghana, the MYD is highly susceptible to Cape Saint Paul Wilt. In 2015, only in West Africa, one variety shows some resistance to a LYTS: the Sri Lanka Green Dwarf. Unfortunately, in 2015, there is no known variety able to resist to the Caribbean LY.

Conclusion.

The LYTS and particularly LY of the Caribbean and Central America, by its velocity, its high infectivity, the absence of resistant varieties and a quasi uncontrollable insect vector, are a very serious threat to coconut and other palms

of Brazil. For this kind of disease, the epidemiosurveillance is the first weapon. We must act quickly at the very first cases. Otherwise, the disease becomes uncontrollable.

Under the CNPq program "Science without borders ("Special visiting scientist") the author and Embrapa Tabuleiros Costeiros Aracaju, under the leadership of Dr. Leandro Diniz, started early 2015, a three-year collaborative project on the risks of introduction of new diseases of coconut and other palm species in Brazil, with a focus on the LY.