

Losses to Lethal Yellowing Cast Doubt on Coconut Cultivar Resistance

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After nineteen years' exposure in an area of active lethal yellowing disease (LY) at Fort Lauderdale, Florida, a coconut cultivar trial recorded losses of 74 of the 106 Malayan Dwarf (70%) and 10 of the 12 hybrid Maypan (83%) coconuts to the disease. The loss of 0 of 4 true-to-type Fiji Dwarf coconuts suggests that this cultivar deserves further testing.

Lethal yellowing is a widespread and fatal disease of coconut (*Cocos nucifera* L.) and at least 37 other species of palms in Florida and the Caribbean region (Harrison et al. 1995). The disease is believed to be caused by phytoplasmas (formerly known as mycoplasma-like organisms or MLOs) (Beakbane et al. 1972, Heinze et al. 1972, Plavsic-Banjac et al. 1972). These unculturable, cell wall-less organisms belong to a class of bacteria known as mollicutes (Seemüller et al. 1998). The phytoplasma is transmitted to palms during feeding activities by *Myndus crudus*, a phloem-feeding planthopper (Homoptera: Cixiidae) (Howard et al. 1983). Similar phytoplasma diseases of coconut include Cape St. Paul wilt in Ghana, Awka wilt in Nigeria, Kaincopé disease in Togo, Kribi disease in Cameroon, lethal disease in Tanzania, Kenya, and Mozambique, Kalimantan wilt and Natuna wilt in Indonesia, and several other lesser known diseases of coconuts in other parts of the world (Eden-Green 1997a, 1997b).

Although tetracycline injection (McCoy 1972) has been highly effective in preventing LY infections in coconuts, this control measure has usually been considered a temporary solution to the problem.

Long-term management recommendations have always included the planting of LY-resistant palm species and coconut cultivars (Been 1995; McCoy 1983).

Lethal yellowing resistance field trials in Jamaica suggested that some coconut cultivars had excellent resistance to this disease. Been (1981), Harries (1973), and Whitehead (1968) reported that Malayan Dwarf and hybrid Maypan (Malayan Dwarf × Panama Tall) coconuts were highly resistant to LY, thus these varieties became the primary focus of coconut replanting efforts in Florida and the Caribbean (Harries et al. 1970–71, Harries & Romney 1974). In the early 1980's a field trial was begun at the University of Florida Fort Lauderdale Research and Education Center (FLREC) to test the performance of these and other promising coconut cultivars. This report is a summary of the data generated from that study.

Materials and Methods

During the summer of 1980, about 200 certified seed nuts of Malayan Dwarf (included green and gold (red) color forms) and smaller numbers of Maypan, Ceylon Dwarf, King, Panama Tall, Red

Spicata, and Fiji Dwarf (Niu Leka) were imported to Florida from the Jamaican Coconut Industry Board (CIB). Although a high percentage of seeds germinated, all of the King and Ceylon Dwarf seedlings died during the severe freezes of 1980–1981. In the spring of 1982 we planted a 5-acre (2-ha) palm grove at the FLREC with the surviving seedling coconuts, along with a wide range of other palm species to test their relative susceptibility to LY. The border on one side of this triangular plot consisted of a row of 33 Jamaica Tall (highly susceptible) coconuts to insure that LY would be active at this site. Within this plot, blocks consisting of 48 green Malayan Dwarf, 28 golden (red) Malayan Dwarf, and 12 Fiji Dwarf coconuts were established. Of the 10 surviving Fiji Dwarf coconuts, we noted that only 4 developed into true-to-type dwarf palms, the remaining 6 being “tall” off-types. In the area remaining in the trial plot 4 Red Spicata, 6 golden Malayan Dwarf, 10 Panama Tall, and 12 Maypan coconuts were interplanted among about 60 other species of palms. In addition, 24 green Malayan Dwarf coconuts were planted in front of the main building at the FLREC.

Of the palms that were diagnosed as having LY, at least 75% were analyzed by N. A. Harrison, who confirmed that the LY pathogen was present, initially by using electron microscopy (mid 1980's), and later by DNA probes or PCR methodology (Thomas et al. 1980, Harrison et al. 1992, 1994).

Results and Discussion

Lethal yellowing became active at this site and remained so from the mid 1980's until about 1999. During that time, 91% (30 of 33) of the Jamaica Tall, 70% (74 of 106) of the Malayan Dwarf, 83% (10 of 12) of the Maypan hybrids, and 50% (5 of 10) of the Panama Tall coconuts died from LY (Table 1). Losses of about 50% for the Panama Tall coconuts in this study are similar to those reported by Been (1981) for Jamaica. However, our losses for Malayan Dwarf and Maypan coconuts are much higher than reported by Been (1981) for Jamaica, where losses for Malayan Dwarfs were less than 4% and those for Maypan were about 12%.

In 1987, Howard et al. reported “unusually high” losses for Malayan Dwarf and Maypan coconuts at several sites in south Florida and Jamaica. The percentage of coconuts that died at these sites varied from about 11 to 40%. Since LY does not kill all susceptible palms in any one year, losses usually continue to occur over time for as long as the disease remains active at a particular site. If the sites in Florida mentioned by Howard et al. (1987)

had been monitored continually over a longer time frame as in this 19-year study, perhaps the percentage of Malayan and Maypan coconuts dying from LY would have been higher. Furthermore, the high incidence of LY-related deaths in Malayan Dwarf and Maypan coconuts in Florida is not restricted to this study at the FLREC or those sites mentioned by Howard et al. (1987). The authors are aware of several additional large municipal plantings (e.g., Pembroke Pines and Pompano Beach, Florida) of these coconut varieties in south Florida where losses are estimated to be well over 50%.

The premise that Malayan Dwarf and Maypan coconuts are highly resistant to LY is based on cultivar trials in Jamaica (Whitehead 1968, Harries 1973). Since then the high resistance of these varieties has become almost universally accepted and reports of higher LY losses in these varieties have generally been viewed as anomalous. However, recent observations from Jamaica describe severe outbreaks of LY in some large Malayan and Maypan coconut plantations (Myrie & Been 2001, Schuiling 2001). Myrie and Been (2001) report the loss of 747 of 874 (85%) Malaysians at one site and 782 of 792 (99%) Maypans at another. Schuiling (2001) describes “massive” losses of Malayan and Maypan coconuts due to LY at eight additional sites. If all the reports of Malayan Dwarf and Maypan losses to LY in Florida and Jamaica (Howard et al. 1987, Myrie & Been 2001, Schuiling 2001, and this study) are considered, then it would appear that those earlier results from Jamaica (Been 1981) are anomalous, as subsequent observations in Florida and Jamaica have failed to support those claims of LY resistance for Malayan and Maypan coconuts.

Although our 70% loss rate over 19 years for Malayan Dwarf coconuts and 83% for Maypans are lower than the 91% loss rate for Jamaica Talls, from a practical standpoint Malayan and Maypan coconuts cannot be considered “resistant” to this disease. The fact that only about 5% of the Malaysians in the first Jamaican trials died from LY (Been 1981) does not prove that they are resistant – only that for reasons yet unknown they did not contract this disease during the time period that their trials were conducted. However, documentation of high loss rates among Malayan Dwarf and Maypan coconuts to LY at this and other sites in Florida and Jamaica is evidence that these varieties are not inherently (i.e., genetically) resistant to this disease and that when duly exposed, they may die at rates nearly as high as those of the “highly susceptible” Jamaica Tall variety.

Table 1. Losses of coconut cultivars due to lethal yellowing (LY) at the University of Florida Fort Lauderdale Research and Education Center, 1982-2001.

Cultivar	No. planted	Losses to LY	Percent loss
Jamaica Tall	33	30	91
Malayan Dwarf	106	74	70
Maypan	12	10	83
Panama Tall	10	5	50
Red Spicata	4	3	75
Fiji Dwarf (Niu Leka)	4	0	0
Fiji Dwarf (off-types)	6	3	50

A number of reasons have been suggested to account for the high loss rate among Malayan and Maypan coconuts in Florida and Jamaica, including fertility, weather, insect vector populations, ground cover, etc., but none of these factors seems to be consistently correlated with LY losses (Howard et al. 1987). The possibility that the LY phytoplasma has mutated and is now able to kill Malayan Dwarf and Maypan, as well as Jamaican Tall coconuts, has been raised. This may be a plausible explanation in Jamaica, where current high loss rates contrast sharply with the early reports of minimal losses of Malayan and Maypan coconuts to the disease. However, even in the mid 1980's there were several sites in Jamaica that experienced unexpectedly high losses of those varieties (Howard et al. 1987). It is hoped that molecular studies of the LY agent currently in progress will clarify this issue.

Similarly, it had been suggested that the Malayan Dwarfs dying from LY may be genetically different from the original population described by Harries et al. (1970). Certainly, many of the coconuts offered for sale as Malayan Dwarfs in Florida since the mid 1980's are phenotypically distinct from the true Malayan Dwarf type. However, all but 1 of the 106 Malayans we received from the CIB were phenotypically true-to-type. Whether these, as well as those planted throughout Jamaica that subsequently died from LY, are as LY-resistant as those original Malayan Dwarfs remains to be determined by DNA analysis.

In addition to the susceptibility of Malayan Dwarf and Maypan coconuts, our study also suggests a high degree of LY resistance in the Fiji Dwarf (Niu Leka) cultivar. None of the four true-to-type Fiji Dwarfs at this site died from LY, nor did any of the 12 additional true-to-type Fiji Dwarfs planted at the US Department of Agriculture Chapman Field Station in Miami, FL (A.W. Meerow, pers. comm.). Very high LY disease pressure during the 1980s and 1990s killed a high number of Malayan and Maypan coconuts at both sites. Sample sizes at both sites were small, however, and additional

testing at other sites is needed to determine if this cultivar is indeed highly resistant.

Data for Fiji Dwarf plantings in Jamaica showed about 50% loss due to LY (Been 1981). However, due to the high degree of heterozygosity in this Jamaican Fiji Dwarf population even the controlled pollination methods used in the propagation of Fiji Dwarfs by the CIB resulted in a number of tall "off-type" recombinants being produced from true-to-type dwarf parents (Whitehead 1968, Harries, pers. comm.). The resistance data for Fiji Dwarf coconuts published by Been (1981) do not distinguish between true-to-type and off-type Fiji Dwarf coconuts due to the relatively young age at which these palms were exposed to LY (D. Romney, pers. comm.). It is possible that if the LY losses for true-to-type Fiji Dwarfs had been separated from the off-types, the Jamaican results for true-to-type Fijis might have been lower than reported. Fiji Dwarf also showed some degree of resistance compared to other varieties of similar age in trials in Tanzania where the related lethal disease was rampant (Kullaya et al. 1995). Malayan Dwarf coconuts at these same sites experienced loss rates as high as 95% from this disease.

Hugh Harries (pers. comm.) has stated that the original Fiji Dwarf coconuts imported by the CIB from St. Lucia and Fiji segregated phenotypically for dwarf and tall habit, as well as for LY resistance when selfed or sib pollinated. He has speculated that the Fiji Dwarf coconut may be no more than a dwarf (and LY-resistant) mutant selected from the Fiji Tall population on Fiji. If this is so, then the tall off-type Fiji Dwarfs obtained from the CIB may in fact be genotypically and phenotypically Fiji Tall, a highly susceptible variety. It is hoped that future DNA studies will clarify this issue. However, the high degree of heterozygosity among Fiji Dwarf coconuts means that only cloning or seed propagation by controlled pollination of known homozygous individuals can be used predictably to reproduce this apparently resistant phenotype.

In conclusion, this study supports a growing body of evidence that Malayan Dwarf and Maypan coconuts are not highly resistant to LY as previously claimed. Although the Fiji Dwarf appears to be a promising LY-resistant cultivar for ornamental use in south Florida, additional field trials in Florida and elsewhere may or may not support this hypothesis.

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