# Fusarium Wilt of Queen Palm and Mexican Fan Palm: A Devastating, New Palm Disease in California

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For nearly 50 years landscape managers throughout California have had to contend with the serious and fatal Fusarium wilt disease of Canary Island date palm caused by the fungal pathogen *Fusarium oxysporum* f. sp. *canariensis* (Broschat et al. 2014; Downer et al. 2009b; Elliott et al. 2016; Hodel 2009a, 2012b, 2019). As the common and pathogen subspecies names indicate, this pathogen attacks and causes disease in Canary Island date palms (*Phoenix canariensis*), and so far, at least in the landscape, sparing all other species of palms.

Unfortunately, in early October, 2019, a second subspecies of this pathogen, *Fusarium oxysporum* f. sp. *palmarum*, was detected and confirmed attacking and killing queen palms (*Syagrus romanzoffiana*) at a private residence in Fallbrook, California in northern San Diego County (**Figs. 1-2**). This pathogen attacks more than one species of palms; hence, the subspecies name f. sp. *palmarum* (Broschat et al. 2014; Elliott 2009, 2017; Hodel 2012b). This disease is widespread in Florida where it is commonly called Fusarium wilt of queen palm and Mexican fan palm (*Washingtonia robusta*) because it primarily attacks these two palm species. Although reportedly rare, this disease also infrequently attacks Canary Island date palm and the mule palm (*×Butiagrus nabonnandii*), a hybrid of queen palm and pindo palm [*Butia odorata* (misapplied in the trade as *B. capitata*)].

The two Fusarium wilt pathogens have many similarities, including their lethality, probable mode of spread, symptoms, and management strategies and practices, but differ in several ways, the primary ones being their host specificity or lack thereof and, of course, their pathogen subspecies. Subspecies f. sp. *canariensis* attacks only one species of palm in the landscape, the Canary Island date palm, while the subspecies f. sp. *palmarum* attacks at least three species and one hybrid of palms, two of which, queen palm and Mexican fan palm, are among California's most common landscape palms.

Here we provide a summary of this new, fatal Fusarium wilt of queen palm and Mexican fan palm, compare it with the original Fusarium wilt of Canary Island date palm, and discuss management strategies.

**1.** A queen palm is nearly dead in Fallbrook, California from Fusarium wilt of queen palm and Mexican fan palm.

**2.** Queen palms are dead or dying in Fallbrook, California from Fusarium wilt of queen palm and Mexican fan palm.

**3.** A worker ascends a queen palm in Fallbrook, California dying from Fusarium wilt of queen palm and Mexican fan palm to begin the felling and sample collection process.

## History

In June, 2019, senior author Hodel received a call about rapidly declining queen palms at a private residence in Fallbrook, California (**Figs. 1-2**). He visited the site and observed numerous dead and dying queen palms. On July 11, 2019, he returned to the site, and a dying palm was felled and sectioned (**Fig. 3**). Hodel photographed the dying palms and collected samples of symptomatic leaves and trunk and took them to co-author Santos at Waypoint Analytical in Anaheim, California. Santos was able to culture a *Fusarium oxysporum* from the trunk samples and sent the isolates to the University of Florida for molecular analysis to determine which subspecies of this pathogen was present. On October 7, 2019, we learned that the University of Florida had confirmed the pathogen was *Fusarium oxysporum* f. sp. *palmarum*, which is the first documented record of this serious and worrisome pathogen and its disease in California.

## Symptoms and Diagnosis

Symptoms of Fusarium wilt of queen palm and Mexican fan palm are mostly like those of Fusarium wilt of Canary Island date palm. Because the pathogens attack the water-conducting tissue (xylem) of the palm, leaf desiccation and death result.

Initial symptoms occur on the lower or older leaves in the palm canopy (Elliott 2017). Leaves in the process of dying typically exhibit one-sided discoloration or necrosis. Pinnae (pinnate leaves) or segments (palmate leaves) on one side of the leaf blade turn chlorotic or necrotic while those on the opposite side of the blade remain green and healthy. Eventually the initially healthy pinnae and segments on the opposite of the blade turn brown and the entire leaf dies.

On leaves showing one-sided necrosis or death a yellowish to reddish brown or dark brown streak will typically occur along and on the same side of the petiole or rachis as the affected pinnae or segments (Elliott 2017). This streak can occur along the full length of the petiole and rachis or only on portions of them. Cross sections of the petiole or rachis with streaking show internal discoloration.

Affected leaves on diseased queen palms in Fallbrook did not conspicuously show the markedly contrasting one-sided necrosis, brown on one side and green on the other, as described for this disease in Florida and for that of Fusarium wilt of Canary Island date palm in California. One-sided necrosis was present on the Fallbrook queen palms but the “healthy” side was already chlorotic (**Fig. 4**). In fact, pinnae on both sides and toward the tip of the leaf blade were chlorotic, and in leaves just starting to show one-sided discoloration, pinnae on both sides of the rachis showed tip chlorosis although on one side it was markedly more intense and extensive (**Fig.** 5) . These uncharacteristic discoloration patterns might be due to the unusually rapid progression of this disease and/or preexisting nutrient deficiencies. Streaking of the

**4.** One-sided necrosis, characteristic of Fusarium wilt of queen palm and Mexican fan palm, was present on the Fallbrook queen palms but the "healthy" side was already chlorotic.

**5.** In leaves on queen palms just starting to show one-sided discoloration from Fusarium wilt of queen palm and Mexican fan palm, pinnae on both sides of the rachis showed tip chlorosis although on one side it was markedly more intense and extensive.

**6.** Petiole streaking of queen palms dying from Fusarium wilt of queen palm and Mexican fan palm was subdued and yellowish.

**7.** In petiole cross sections of queen palms dying from Fusarium wilt of queen palm and Mexican fan palm, internal necrosis was not especially expansive.

petiole and rachis on the diseased queen palms was subdued, appearing yellowish (**Fig. 6**), and in petiole cross sections internal necrosis was not especially expansive (**Fig. 7**).

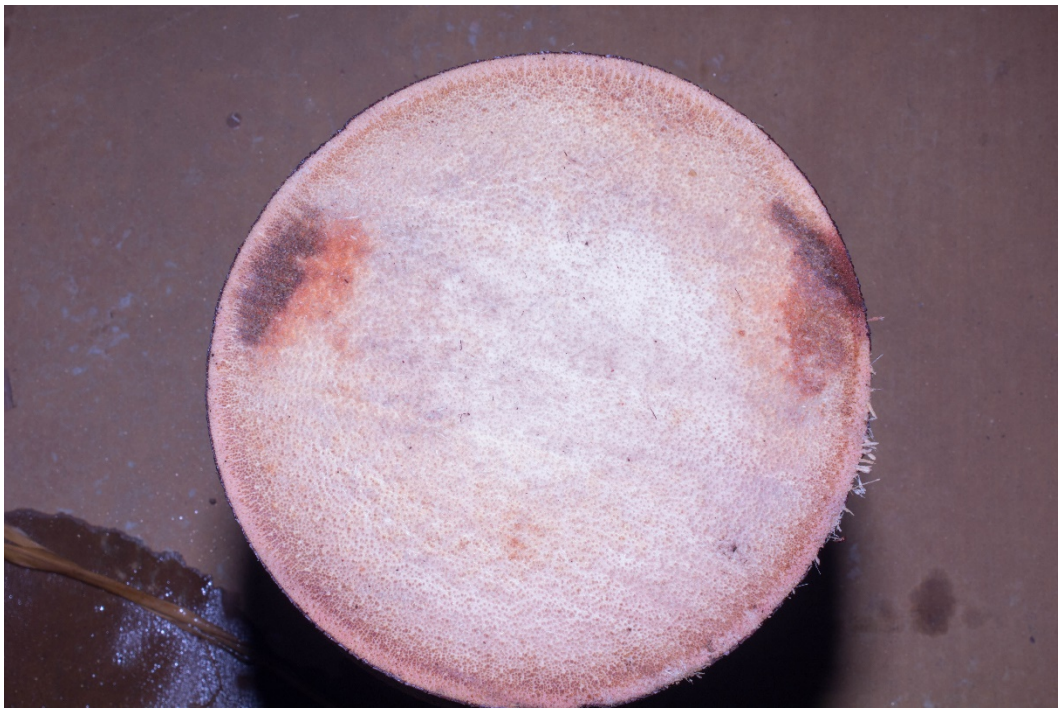
Symptoms progressively move up the canopy from the lowest or older leaves to the upper, younger leaves, killing the spear leaf in the top center of the canopy last (Elliott 2017). In contrast to Fusarium wilt of Canary Island date palm, where death can occur within several months or the palm can linger for a year or more, death occurs rapidly, within two to three months, with Fusarium wilt of queen palm and Mexican fan palm (Elliott 2017). This rapid death creates a characteristic canopy symptom of this disease, one where the dead leaves do not droop or break but remain relatively rigid in their natural position.

Trunk cross sections displayed rather dramatic, dark brown to nearly black discoloration toward the periphery of the central cylinder and into the cortex (**Fig. 8**). Initial discoloration was confined to smaller, discrete sections; these showed a general dark brown color with embedded dark gray vascular bundles at the periphery of the central cylinder while tissue just inside toward the center of the central cylinder was a pinkish orange color (**Fig. 9**). These smaller areas enlarged nearly to encircle the central cylinder (**Fig. 10**); however, intact pseudobark obscured these dramatic internal changes, making them externally invisible.

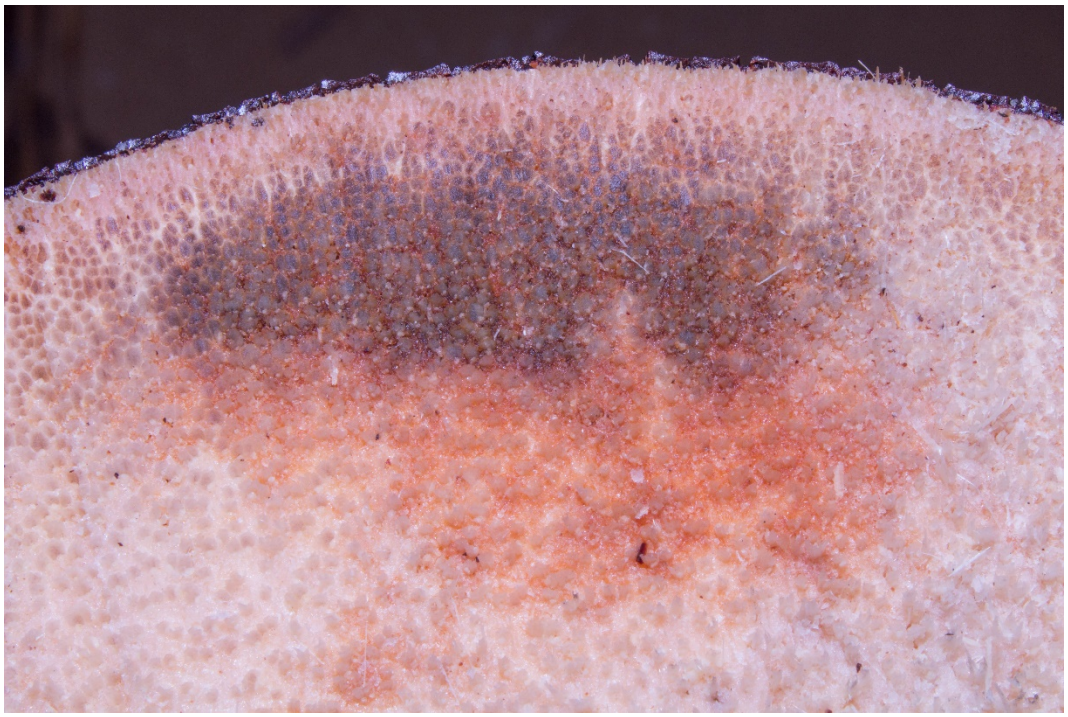
As with Fusarium wilt of Canary Island date palm, symptoms alone are often sufficient to diagnosis Fusarium wilt of queen palm and Mexican fan palm in the field. Infected palms typically have an inordinate quantity of brown, dead leaves and a much-reduced quantity of green, healthy-appearing leaves in the canopy, and leaves in the process of dying have the symptoms described earlier. In an intensely managed landscape where dead or dying leaves are immediately removed, infected palms would have only a few green leaves in the canopy. Death is typically rapid, within three months. Although usually unnecessary, to confirm the field diagnosis, a laboratory must isolate the *Fusarium oxysporum* from the diseased palm and then perform a molecular analysis to determine if it is f. sp. *palmarum*.

Alone, one-sided leaf death is diagnostic for neither Fusarium wilt palm diseases. Other, minor, mostly nuisance diseases, like petiole and rachis blight, can cause one-sided leaf death and petiole streaking that look similar to that of Fusarium wilt of queen palm and Mexican fan palm; however, palms with these minor diseases seldom have more than one or two affected leaves and the diseases are rarely fatal (Elliott 2015, 2017; Hodel 2009a, 2009b, 2012b, 2019).

Ganoderma butt rot, which is rare on palms in California, can cause leaves to die progressively from the bottom to the top of the canopy. However, Ganoderma butt rot is typically a slower disease process than that of Fusarium wilt of queen palm and Mexican fan palm and does not show one-sided leaf death (Broschat et al. 2104: Downer et al 2009b: Elliott and Broschat 2018; Hodel 2012a, 2012b).



**8.** Trunk cross sections of queen palms dying from Fusarium wilt of queen palm and Mexican fan palm displayed rather dramatic, dark brown to nearly black discoloration toward the periphery of the central cylinder and into the cortex.



**9.** Initial discoloration was confined to smaller, discrete sections; these showed a general dark brown color with embedded dark gray vascular bundles at the periphery of the central cylinder while tissue just inside toward the center of the central cylinder was a pinkish orange color.

**10.** Smaller discolored areas enlarged nearly to encircle the central cylinder.

A new disease called lethal bronzing disease (formerly Texas Phoenix palm decline) also attacks and kills queen palms; however, this disease is not yet in California and the leaf death pattern in the canopy is the opposite of that of Fusarium wilt of queen palm and Mexican fan palm: the spear leaf dies early in the disease process rather than at the end (Bahder and Helmick 2019; Broschat at al. 2014; Elliott 2009; Hodel 2012a, 2012b).

## Hosts and Range

In contrast to Fusarium wilt of Canary Island date palms, which only attacks the latter species, the primary hosts of this new Fusarium wilt disease are queen palms and Mexican fan palms; other infrequent hosts include the Canary Island date palm and the mule palm.

Fusarium wilt of queen palms and Mexican fan palms is widespread in Florida and in the Houston-Galveston area of Texas (Broschat et al. 2014, Elliott 2017), and has been recently confirmed on queen palms in Gilbert, Arizona. Now California can be included in the range of this disease although currently it has only been confirmed on queen palms.

The confirmed detection of Fusarium wilt of queen palm and Mexican fan palm at the Fallbrook site might not be its first occurrence in California. Nine years ago a queen palm in the Venice section of Los Angeles rapidly wilted and died and *Fusarium oxysporum* was isolated from the

**11.** In 2010 a queen palm in the Venice section of Los Angeles rapidly wilted and died. *Fusarium oxysporum* was isolated from the dead palm but the variety of this pathogen was not determined.

**12.** In 2019 a queen palm in Long Beach showed classic symptoms of Fusarium wilt of queen palm and Mexican fan palm.

dead palm but the variety of this pathogen was not determined (**Fig. 11**). More recently Hodel observed a queen palm dying in Long Beach that exhibited wilt symptoms (**Fig. 12**). In the affected Venice queen, a trunk cross section appeared like those of the Fallbrook palm. Occasionally we have observed Canary Island date palms with Fusarium wilt-like symptoms but the leaves remained in a natural position, indicating that death was rapid. Whether Fusarium wilt of queen palm and Mexican fan palm, which always causes rapid death, or Fusarium wilt of Canary Island date palm, which can cause rapid or delayed death, was responsible was not determined.

## Management

Like Fusarium wilt of Canary Island date palm, Fusarium wilt of queen palm and Mexican fan palm is fatal; no cure exists. Where the spread of Fusarium wilt of Canary Island date palm can be mostly prevented through the proper disinfection of pruning and other tools used on the palms, the same might not hold true for Fusarium wilt of queen palm and Mexican fan palm because observations in Florida suggest airborne spores (conidia) might be the primary means of pathogen spread. Birds or insects might also possibly spread the pathogen (Elliott 2017).

Wind- or animal-mediated spread of Fusarium wilt of queen palm and Mexican fan palm is in stark contrast to spread of Fusarium wilt of Canary Island date palm in California. In this latter disease, pathogen spread only occurs on pruning tools or movement of soil and water (Downer et al. 2009a, 2009b; Hodel 2009a, 2012a, 2012b, 2019). Some landscape managers in California have contended that Fusarium wilt of Canary Island date palm can also be spread by wind and birds although these modes of pathogen spread have never been proven; to the contrary, pathogen spread on pruning tools and movement of soil and water has been proven.

Like Fusarium wilt of Canary Island date palm, Fusarium wilt of queen palm and Mexican fan palm can also be spread from palm to palm on tools; thus, all tools, including saws, hoes, rakes, shovels, and soil probes, among others, used for horticultural practices should be thoroughly disinfected prior to use on each palm (Elliott 2017; Downer et al. 2009a, 2009b; Hodel 2009a, 2012a, 2012b, 2019). Use manual pruning saws rather than chain saws because the latter are difficult if not impossible to clean and disinfect adequately. Also, chain saws are powerful tools, and in the hands of an overzealous pruner, are likely to cause more severe wounding. In some instances, especially with extremely valuable palms, landscape workers will employ a new, unused saw for each tree, discarding it after use, or have a dedicated saw for each palm that is used on that palm and only that palm (Downer et al. 2009a; Hodel 2009a, 2012b).

Note that recently infected palms might not yet show disease symptoms; thus, disinfect all tools prior to use on a palm even if the previous palm upon which the tools were used appeared healthy (Elliott 2017). Limit pruning to dead or dying leaves only and avoid shaping

**Table 1. Materials and Soaking Times for Disinfecting Tools for Fusarium Wilt Diseases of Palms (Elliott 2017).**

| Material | Solution | Soaking Time |
|---|---|---|
| household bleach (Chlorox®) | 25% (1 part bleach + 3 parts water) | 5 to 10 minutes |
| pine oil cleaner (Pine So®) | 25% (1 part bleach + 3 parts water) | 5 to 10 minutes |
| rubbing alcohol (70% isopropyl) | 50% (1 part alcohol + 1 part water | 5 to 10 minutes |
| denatured alcohol (95%) | 50% (1 part alcohol + 1 part water | 5 to 10 minutes |

and sculpting of "pineapples" (dead or alive persistent leaf bases just below living leaves) and skinning or peeling trunks of leaf bases because these practices can create permanent wounds that facilitate pathogen entry into the palm (Elliott 2017; Hodel 2009a, 2012b, 2019). The pathogen can also likely be spread indirectly during pruning because studies with Fusarium wilt of Canary Island date palm in California showed that sawdust generated from cutting a petiole 15 m up in an infected Canary Island date palm drifted in the wind for 30 m and still contained the pathogen *Fusarium oxysporum* f. sp. *canariensis* (Hodel 2009a, 2012b); thus, avoid pruning during windy weather or at windy times of the day.

To disinfect tools adequately, brush them clean of plant debris then soak them in a disinfectant solution (Downer et al 2009a, 2009b; Elliott 2017; Hodel 2009a, 2012b, 2019) (**Table 1**). Rinse with clean water, wipe dry with a clean cloth, and apply a light oil if necessary. Some tools can also be heat treated for 10 seconds with a hand-held butane torch (Downer et al. 2009a).

Movement of soil and water from infected palms to healthy palms could also likely spread the pathogen (Hodel 2009a, 2012b, 2019). Avoid movement of soil to other landscape sites and control water run-off. The pathogen that causes Fusarium wilt of Canary Island date palm can remain in the soil for at least 25 years and attack a newly planted Canary Island date palm (Downer et al. 2009b; Hodel 2009a, 2012b, 2019). The pathogen that causes Fusarium wilt of queen palm and Mexican fan palm likely behaves in the same or similar manner; thus, it would be prudent not to replant with a queen palm, Mexican fan palm, or other susceptible species where one had died previously of Fusarium wilt (Elliott 2017).

Because palms with Fusarium wilt will eventually die, it is prudent to remove them as soon as feasible (Downer et al. 2009b; Elliott 2017; Hodel 2009a, 2012b, 2019). To avoid spreading the pathogen at removal, it is best to excavate the root ball and remove the palm with the crown of leaves, trunk, and root ball still attached and intact, and crane it out in one single operation if possible (Downer et al. 2009b; Hodel 2009a, 2012b, 2019). Any cutting, grinding, digging or other operations that can spread diseased plant parts should be contained by plastic or wooden

barriers and all the debris captured, bagged, and removed for disposal. Removed palms should be incinerated or sent to a landfill, not to a waste recycling program (Hodel 2009a, 2012b, 2019).

If the palm landscape motif is to be continued, replace diseased palms with species not yet determined to be susceptible to either Fusarium wilt disease. Replace the Canary Island date palm with the Chilean wine palm (*Jubaea chilensis*) or other species of date palms, including the date palm (*Phoenix dactylifera*). Staminate (male) plants of the date palm might be especially considered, not only for their probably Fusarium wilt resistance but also because they are more robust than the pistillate (female) fruit-bearing plants and, thus, more closely imitate the larger, more robust habit of the Canary Island date palm.

Replacement species to consider for queen *palm* include the date palm, wild date palm (*Phoenix sylvestris*), king palm (*Archontophoenix cunninghamiana*), kentia palm (*Howea forsteriana*), royal palms (*Roystonea* spp.), and various *Dypsis* spp. from Madagascar now making their way into the trade. Replacement species for the Mexican fan palm include the Mexican blue palm (*Brahea armata*), San Jose hesper palm (*B. brandegeei*), Guadalupe palm (*B. edulis*), Australian and Chinese fountain palms (*Livistona australis* and *L. chinensis*), the Bismarck palm (*Bismarckia nobilis*), and, in the desert only, the California fan palm (*Washingtonia filifera*).

The pindo palm, one of our hardiest and most tolerant and adaptable species, has not been reported to be susceptible to either Fusarium wilt disease; however, that it is one of the parents of the susceptible mule palm, it should probably not be specified as a replacement species for palms that have died from Fusarium wilt of queen and Mexican fan palm. Also, remember that host lists of Fusarium wilt of Canary Island date palm and especially Fusarium wilt of queen palm and Mexican fan palm later could expand and encompass some of the replacement species suggested above. Indeed, although undocumented in the landscape, in a Fusarium wilt of Canary Island date palm host trial in a field at the University of California Research and Extension Center in Irvine, California, it was found that some individuals of the Senegal date palm (*Phoenix reclinata*) and California fan palm became infected with *Fusarium oxysporum* f. sp. *canariensis* (Downer et al. 2009b).

**Table 2** provides a summary of the similarities and differences between Fusarium wilt of queen palm and Mexican fan palm and Fusarium wilt of Canary Island date palm.

**Table 2. Comparison of Fusarium Wilt of Queen Palm and Mexican Fan Palm with Fusarium Wilt of Canary Island Date Palm (Downer et al. 2009b; Elliott 2017; Hodel 2009a, 2009b, 2019). Differences in bold type.**

| Name | Fusarium wilt of queen palm and Mexican fan palm | Fusarium wilt of Canary Island date palm |
|---|---|---|
| Pathogen | *Fusarium oxysporum* f. sp. ***palmarum*** | *Fusarium oxysporum* f. sp. ***canariensis*** |
| Symptoms | | |
| Canopy | Lower, older leaves typically die first, and then moving progressively upward in canopy. | Lower, older leaves typically die first, and then moving progressively upward in canopy. |
| Leaf blade | Initially one-sided death. | Initially one-sided death. |
| Petiole/rachis | External and internal dark brown streaking. | External and internal dark brown streaking. |
| Trunk | Dark brown longitudinal degradation toward trunk periphery. | Dark brown longitudinal degradation toward trunk periphery. |
| Death rate | **Quick**, within three months of first symptoms. | **Quick to slow**, three months to one year or more. |
| Hosts (landscape) | **Queen palm, Mexican fan palm**, Canary Island date palm, **mule palm**. | Canary Island date palm. |
| Range (within U.S.A) | Florida, **Texas**, **Arizona**, California. | Florida, California. |
| Transmission | **Wind**, tools, **likely soil and water movement**; **perhaps birds and insects**. | Tools, **soil and water movement**. |
| Management | | |
| Possible through exclusion | **No.** | **Yes.** |
| Clean and disinfect thoroughly all tools before work on each susceptible palm. | Yes. | Yes. |
| Replace with a susceptible palm species where one died from the disease. | No. | No. |
| Control soil and water movement from infected palms. | Yes. | Yes. |

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Publication Date: 2 December 2019.

PalmArbor: *http://ucanr.edu/sites/HodelPalmsTrees/PalmArbor/*
Editor-In-Chief: Donald R. Hodel

Hodel Palms and Trees: *http://ucanr.edu/sites/HodelPalmsTrees/*