The New Fusarium Wilt Disease of Palms in California Now Confirmed on Mexican Fan Palms

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In an earlier paper in these pages (Hodel and Santos 2019) we reported on a new, deadly Fusarium wilt disease of palms detected on queen palms (*Syagrus romanzoffiana*) at a private residence in Fallbrook, in northern San Diego County, California. Called Fusarium wilt of queen palm and Mexican fan palm, it is common in Florida and, as the name implies, it attacks more than one species of palms. In Florida, attacked palms include queen palm, Mexican fan palm (*Washingtonia robusta*), infrequently Canary Island date palm (*Phoenix canariensis*), and rarely the mule palm (*×Butiagrus nabonnandii*), a hybrid of the queen palm and pindo palm [*Butia odorata* (misapplied in the trade as *B. capitata*)]. The name of the pathogen of this new disease is *Fusarium oxysporum* f. sp. *palmarum*, the latter part of the epithet or subspecies signifying that it attacks more than one species of palms (Broschat et al. 2014; Elliott 2009, 2017; Hodel 2012b).

In contrast, the traditional or original Fusarium wilt disease with which California landscape managers have had to contend for 50 years or so has attacked only one species in the landscape, the Canary Island date palm (*Phoenix canariensis*). The name of the pathogen of Fusarium wilt of Canary Island date palm is *Fusarium oxysporum* f. sp. *canariensis*, the latter part of the epithet or subspecies signifying that it only attacks the Canary Island date palm.

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. Unfortunately, the new Fusarium wilt disease attacks two of California's most common landscape palms, queen palm and Mexican fan palm (**Table 1**).

Our earlier paper discussed and illustrated the new Fusarium wilt disease only on queen palm because it had not yet been detected on Mexican fan palm in California although we also suspected it was on this latter species. That changed in September 2020 when plant pathologists at the California Department of Food and Agriculture confirmed that samples we had collected a few weeks earlier in August on dying Mexican fan palms in the Playa Vista section of Los Angeles tested positive for *Fusarium oxysporum* f. sp. *palmarum* (**Fig. 1**).

Table 1. 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.

1. This Mexican fan palm in the Playa Vista section of Los Angeles, California died from the new disease Fusarium wilt of queen palm and Mexican fan palm.

2. Co-author Paul Santos ascends into the canopy of a Mexican fan palm in west Los Angeles with symptoms of Fusarium wilt of queen palm and Mexican fan palm.

3. This Mexican fan palm in west Los Angeles has leaves in the lower canopy with symptoms of Fusarium wilt of queen palm and Mexican fan palm.

4. A Mexican fan palm in west Los Angeles died from the new disease Fusarium wilt of queen palm and Mexican fan palm.

5. Co-author Paul Santos collects leaves of a Mexican fan palm in Playa Vista showing symptoms of the new disease Fusarium wilt of queen palm and Mexican fan palm.

6. A worker begins to take down a Mexican fan palm in Playa Vista so we can collect samples to determine if the new disease Fusarium wilt of queen palm and Mexican fan palm is present. Note the few stiffly spreading dead leaves.

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. In this account we emphasize this new Fusarium wilt disease on Mexican fan palm to complement our previous account, which emphasized this new disease on queen palms.

History

Since about 2015, we had noticed Mexican fan palm around Southern California, especially in coastal areas, with leaf tip chlorosis and necrosis in the lower part of the canopy, leaf death, and, in a few rare cases, death of the palm. We observed these symptoms in August 2015, September 2017, and May 2019 at one site in on the westside of Los Angeles near the I-405 Freeway (**Figs. 2–4**). We saw it in Laguna Beach in July 2016, Long Beach in October 2019, and in January 2020 in the Playa Vista section of Los Angeles (**Fig. 5**). During this period, we had collected leaf samples for laboratory analysis but no likely pathogen was identified. In the interim, we learned that tissue from the proximal or basal portion of the trunk was likely best for detecting the pathogen responsible for Fusarium wilt of queen palm and Mexican fan palm, and it was trunk tissue that provided the positive test and confirmation of this new Fusarium wilt disease on queen palms in late 2019 (Hodel and Santos 2019).

In August 2020, co-author Santos received a call about declining and dying Mexican fan palms in Playa Vista, not far from where we had observed similar symptoms in January 2020. He notified co-author Hodel and they met at the site, had several symptomatic palms taken down (**Fig. 6**), photographed and collected samples, and sent the samples to the California Department of Food and Agriculture through the Los Angeles County Agricultural Commissioner. By September 18 we received notice that the samples had tested positive for *Fusarium oxysporum* f. sp. *palmarum*, the second 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, wilt, and death result.

Initial symptoms occur on the lower or older leaves in the palm canopy (Elliott 2017) (**Fig. 7**). Leaves in the process of dying typically exhibit one-sided discoloration, chlorosis, and/or necrosis. In the Mexican fan palm with palmate leaves, segments on one side of the leaf blade turn chlorotic and necrotic followed later by those on the opposite side **(Fig. 8**). Frequently the symptoms are not initially restricted to one side of the leaf blade and the chlorotic and necrotic

7. This Mexican fan palm in west Los Angeles has an inordinate quantity of dead and dying leaves in the lower canopy, a symptom of Fusarium wilt of queen and Mexican fan palm.

8–9. With Fusarium wilt of queen palm and Mexican fan palm segments on one side of the blade of lower leaves turn chlorotic and necrotic first, as here at Playa Vista.

10–11. Lower leaves with wedge-shaped, chlorotic or necrotic intrusions into the blade are symptomatic of Fusarium wilt of queen palm and Mexican fan palm. On the left is at west Los Angeles. On the right note the petiole with the brown streak at Laguna Beach.

12. Leaf blade of palm at west Los Angeles showing chlorotic and necrotic intrusions, symptoms of Fusarium wilt of queen palm and Mexican fan palm.

13. Leaf blade of palm at west Los Angeles showing chlorotic and necrotic intrusions, symptoms of Fusarium wilt of queen palm and Mexican fan palm.

14. With Fusarium wilt of queen palm and Mexican fan palm, leaves showing one-sided or wedge-shaped chlorotic and necrotic intrusions typically have a reddish brown or dark brown streak along the petiole, as here in Laguna Beach.

sections appear as single or multiple, wedge- or pie-shaped intrusions into an otherwise green blade (**Figs. 9–13**). Eventually the initially healthy segments become chlorotic and necrotic 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 as the affected pinnae or segments (Elliott 2017) (**Fig. 14**). This streak can occur along the full length of the petiole or only on portions of it. Cross sections of the petiole with streaking show internal discoloration.

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) (**Fig. 15**). 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 with Fusarium wilt of queen palm and Mexican fan palm, within two to three months (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 (**Figs. 6, 15**).

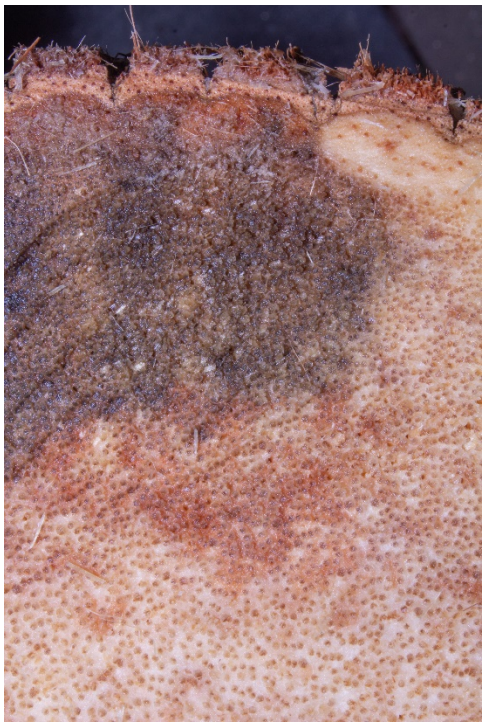
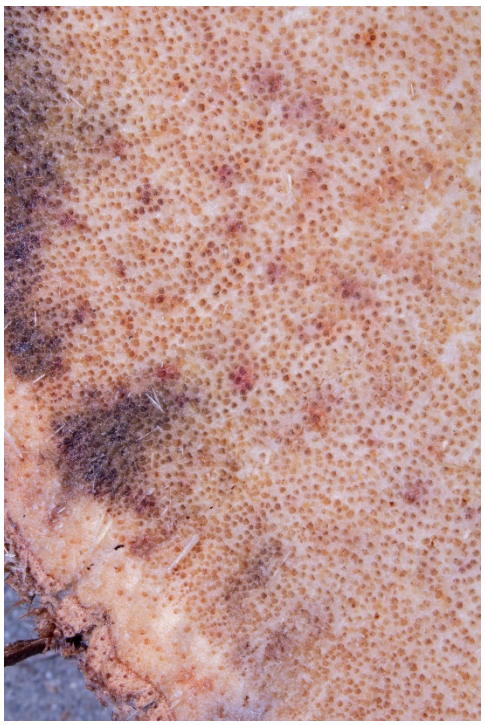
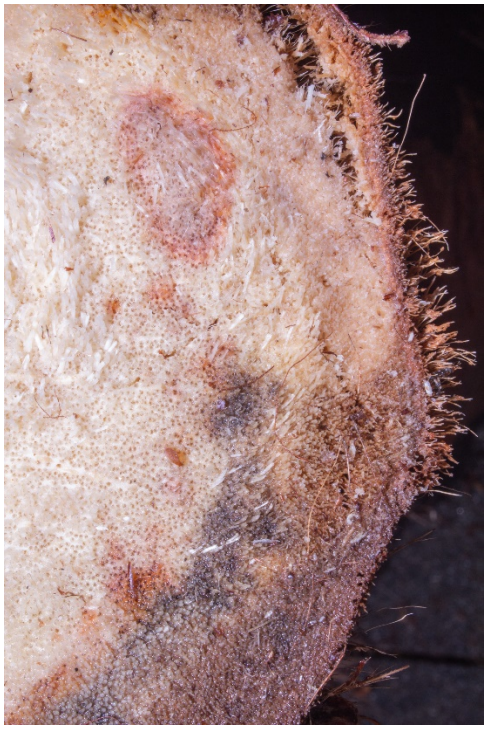
Trunk cross sections of Mexican fan palm displayed rather dramatic, dark brown to nearly black discoloration toward the periphery of the central cylinder and into the adjacent cortex (**Fig. 16**) while tissue just inside toward the center of the central cylinder was pinkish brown (**Fig. 17**). Initial discoloration was confined to smaller, discrete sections ahead of the advancing dark discoloration and slightly toward the center of the central cylinder; these initially were circular and pink to pinkish orange, later enlarging and turning dark brown to nearly black with embedded dark gray vascular bundles (**Figs. 18–20**). These smaller areas enlarged nearly to encircle the central cylinder; 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 although laboratory analysis is necessary for confirmation. 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. 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 not diagnostic for either of the Fusarium wilt palm diseases. Other diseases, like petiole and rachis blight, can cause one-sided leaf death and petiole streaking that look like that of Fusarium wilt of queen palm and Mexican fan palm.

15. With Fusarium wilt of queen palm and Mexican fan palm, symptoms progressively move up the canopy, killing the spear leaf in the top center of the canopy last. Note that some of the leaves are stiffly spreading.

16. With fusarium wilt of queen palm and Mexican fan palm, Trunk cross sections at Playa Vista show dramatic, dark brown to nearly black discoloration toward the periphery of the central cylinder and into the adjacent cortex.


17–20. With Fusarium wilt of queen palm and Mexican fan palm, initial discoloration was confined to smaller, discrete sections ahead of the advancing dark discoloration; these initially were circular and pink to pinkish orange, later enlarging and turning dark brown to nearly black. These samples are at Playa Vista and confirmed the disease.

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).

A common leaf and canopy disease of palms in Southern California, especially in coastal areas, is pink rot (Hodel 2009b, 2012b, 2019). A weak but opportunistic fungal pathogen (*Nalanthamala vermoeseni*) causes pink rot, which typically attacks weakened, stressed, and/or wounded palms, damaging the newly emerging spear leaves first and then sometimes killing the apical meristem leading to death of the palm. Thus, the symptoms of pink rot are opposite of those of Fusarium wilt of queen palm and Mexican fan palm in that the newest leaves typically show symptoms first, the older or lower leaves in the canopy remaining green. At the west Los Angeles site, we observed Mexican fan palms with pink rot in the apical meristem adjacent to palms with the new Fusarium wilt disease, suggesting that pink rot attacked a palm that might have already been weakened by the new Fusarium wilt disease and perhaps killed it before the new Fusarium wilt disease could run its course.

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).

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).

We have also noticed, for the past 20 years or so in southern California, leaf marginal chlorosis and necrosis on Mexican fan palms, symptoms that could initially be mistaken for those of Fusarium wilt of queen palm and Mexican fan palm. However, on closer examination, the chlorosis and subsequent necrosis in these cases is uniformly distributed around the margins of the leaf blade and not in the characteristic, wedge- or pie-shaped pattern of Fusarium wilt of queen palm and Mexican fan palm (**Fig. 21**). Also, petiole streaking is mostly absent, and the condition is not lethal. Why these symptoms seemed to have appeared when they did and what is their cause is unknown at this time. Any number or combination of factors might be responsible, including soil moisture extremes, excessive salt, root disease, herbicide phytotoxicity, soil compaction and poor aeration, and/or excessive fertilizer, among others. Or, perhaps this condition has always been present and is simply more apparent considering greater scrutiny.

21. Uniform leaf marginal chlorosis and necrosis on Mexican fan palms could initially be mistaken for symptoms of Fusarium wilt of queen palm and Mexican fan palm.

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.

With the detection and confirmation of Fusarium wilt of queen palms and Mexican fan palm last year on queen palms in California and now this year on Mexican fan palms, we can surmise that this disease is now here to stay.

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). Further study into the epidemiology of this disease is clearly needed to understand and confirm the primary means of disease spread.

If proven, wind- or animal-mediated spread of Fusarium wilt of queen palm and Mexican fan palm would be in stark contrast to the 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 or around 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). Also, climbing queen palms and Mexican fan palms with spikes for routine pruning, a practice especially common on the latter species, would likely facilitate disease spread.

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 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 2**). 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).

Table 2. 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

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. 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).

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