

CAPS Datasheets provide pest-specific information to support planning and completing early detection surveys.

## **‘*Candidatus Phytoplasma citri*’ (formerly ‘*Ca. P. aurantifolia*’)**

### **Scientific Name**

‘*Candidatus Phytoplasma citri*’  
(Rodrigues Jardim et al. 2023)

### **Synonym(s):**

‘*Candidatus Phytoplasma aurantifolia*’  
(Zreik, Bové, & Garnier 1995)  
*Phytoplasma aurantifolia* (Zreik, Bové, & Garnier)

### **Common Name**

**Disease: Witches’ broom disease of lime (WBDL)**, lime decline,  
Oman witches’ broom disease

**Phytoplasma:** Lime witches’ broom  
phytoplasma

### **Type of Pest**

Phytoplasma

### **Taxonomic Position**

**Class:** Mollicutes

**Order:** Acholeplasmatales

**Family:** Acholeplasmataceae



**Figure 1.** Advanced symptoms of witches’ broom disease (defoliation and dry twigs) caused by ‘*Candidatus phytoplasma citri*’. Photo credit: D.K.

### **Pest Recognition**

*This section describes characteristics of the organism and symptoms that will help surveyors recognize possible infestations/infections in the field, select survey sites, and collect symptomatic material. For descriptions of diagnostic features, see the Identification/Diagnostic resources on the AMPS pest page on the CAPS Resource and Collaboration website.*

### **Pest Description**

Phytoplasmas are plant-pathogenic cell wall-less, unculturable bacteria that are typically transferred by phloem-feeding insect vectors or grafting with infected plant material (Hogenhout et al., 2008; Wang et al., 2024). They are obligate parasites of plants and insects, generally associated with a variety of characteristic symptoms but also reported in asymptomatic plants (Wang et al., 2024). Until recently, phytoplasma taxonomy was based on phylogenetic analysis of 16S ribosomal RNA (16S rRNA) gene sequences

(Bertaccini and Duduk, 2009). Under revised 2022 guidelines (Bertaccini et al., 2022), precise species delineation now incorporates whole-genome average nucleotide identity (ANI) with a 95% threshold, or the analysis of multiple conserved housekeeping genes to resolve closely related taxa.

Phytoplasmas are classified into groups and subgroups based on sequence similarity and restriction fragment length polymorphism (RFLP) analysis of the 16S rRNA gene (Zhao et al., 2009). Under this system, '*Candidatus* Phytoplasma citri', the causal agent of WBDL, is assigned to the phytoplasma classification subgroup 16SrII-B (Al-Subhi et al., 2021; Siampour et al., 2019).

### **Symptoms**

In key lime (*Citrus aurantifolia*): symptoms of WBDL include witches' broom (excessive production of shoots with short internodes and small, light green leaves), abnormal flowers (phyllody), stunting, and reduced fruit production (Chung et al., 2009). Infected trees eventually decline and collapse over 3 to 8 years (Bové et al., 2000). In some cases, trees remain asymptomatic, or they may die back or weaken over time instead of showing typical WBDL symptoms. This slow/symptom free form of the disease is likely due to unfavorable environmental conditions (extremely hot and dry or too cool) (Al-Subhi et al., 2021; Donkersley et al., 2018).

Other citrus: key lime is the primary host, but other citrus species (Bakraee, citron, grapefruit and limequat) may express similar symptoms to key lime when environmental conditions are favorable for disease development (Figure 2, A, B and D) (Al-Sadrani et al., 2025; Azadvar et al., 2014; Salehi et al., 2017; Salehi et al., 2007).



**Figure 2.** Witches' broom disease symptoms including little leaf, shortened internodes, shoot proliferation, witches broom and yellowing in Bakraee (A), grapefruit (B), key lime (C) and limequat (D). Photo credit: M. Salehi (A, B), M. M. Faghihi (C, D)

### Easily Mistaken Species

As of June 2025, there are no known phytoplasmas associated with citrus in the continental United States. The most significant bacterial threat to the domestic industry is Citrus Greening (CG, also known as Huanglongbing, HLB), which is caused by another phloem-limited bacteria 'Candidatus Liberibacter asiaticus'. This disease is currently present in several areas of the United States (APHIS, 2025), which are under quarantine to prevent further spread. While citrus greening can cause blotchy yellowing of leaves and overall tree decline, symptoms that may be confused with the lighter foliage found in WBDL, it does not produce the "witches' broom" shoot proliferation (Badaracco et al., 2017). In Puerto Rico, a phytoplasma within the pigeon pea group (16SrIX) has been associated with orange, tangerine, and lemon. Although found causing symptoms similar to citrus greening, it does not cause witches' broom (Caicedo et al., 2015).

In India, 'Ca. P. cynodontis'-related strains (16SrXIV-A) have been associated with witches' broom symptoms similar to those seen in WBDL (Ghosh et al., 2017). Multiple phytoplasmas have been associated with citrus in Asia, the Caribbean, Central

America, and South America (Noorizadeh et al., 2022). These phytoplasmas can cause witches' broom or nonspecific symptoms such as reduced flowering, stunting, dieback, and decline. Because these pathogens present overlapping symptoms, molecular diagnostics are required to differentiate and confirm the specific pathogen when a disease associated with phytoplasma is suspected in citrus (Noorizadeh et al., 2022).

## Biology and Ecology

WBDL is a devastating disease of citrus caused by a phytoplasma. Phytoplasmas are characterized by a single membrane, lack of a rigid cell wall, and are about 200 to 800 nm in diameter (Hogenhout et al., 2008; Khan et al., 2023). They are obligate, intracellular parasites of plants and insects, residing in the phloem tissue of infected plants and the gut and salivary glands of phloem-feeding insect vectors (Hogenhout et al., 2008). 'Ca. P. citri' can be transmitted by insect vectors and grafting (Al-Subhi et al., 2021; Faghihi et al., 2023).

Phytoplasmas are acquired by insect vectors when they feed on the phloem of infected plants (Hogenhout et al., 2008). After ingestion, cells cross the insect's midgut epithelium into the hemocoel, where they multiply before invading the salivary gland and proliferating further (Haider et al., 2024). Once the salivary glands are colonized, typically after 2 to 6 weeks, the vector can then transmit the phytoplasma to a new host during feeding. The leafhopper *Hishimonus phycitis* is the main known vector responsible for transmitting 'Ca. P. citri' to key lime trees and seedlings (Bagheri et al., 2009; Hemmati et al., 2020). *Diaphorina citri*, the Asian citrus psyllid, can also vector the phytoplasma (Queiroz et al., 2016).

Once a new plant host is infected, 'Ca. P. citri' multiplies in the phloem before symptoms are expressed, resulting in a latent period lasting several months (Al-Ghaithi et al., 2017). The phytoplasma spreads systemically throughout the plant, including the roots (Streten and Gibb, 2006), but 'Ca. P. citri' titers are typically higher in witches' broom tissues (Al-Subhi et al., 2021). One study suggests that witches' brooms may contribute disproportionately to epidemics because they harbor higher phytoplasma titers and attract more *Hishimonus phycitis* vectors likely due to increased tissue for feeding, thereby facilitating disease spread (Al-Subhi et al., 2021). To date, there is no evidence that 'Ca. P. citri' moves into seeds or that it is seed transmitted (Faghihi et al., 2011).

## Known Vectors (or associated insects)

'Ca. P. citri' is naturally spread by the leafhopper *Hishimonus phycitis* (Bagheri et al., 2009; Salehi et al., 2007), which is not known to occur in the United States. The phytoplasma can also be vectored by the Asian citrus psyllid, *Diaphorina citri* (Figure 3) (Queiroz et al., 2016).



**Figure 3.** Vectors of ‘*Candidatus Phytoplasma citri*’: *Hishimonus phycitidis* (left) and *Diaphorina citri* (right)

### Known Hosts

Key lime (*Citrus aurantifolia*) is the preferred host, with evidence of economically significant damage from WBDL (Al-Ghaithi et al., 2018; Donkersley et al., 2018). Grapefruit (*C. paradisi*), bakraee (*Citrus* sp., a rootstock common in the middle east), limequat (*C. aurantifolia* x *Fortunella marginata*), and citron (*C. medica*) are also naturally infected hosts (Al-Sadrani et al., 2025; Azadvar et al., 2014; Faghihi et al., 2017; Salehi et al., 2007). Other *Citrus* species have been infected experimentally using grafting, but they have not been documented as natural hosts.

### Known Distribution

‘*Ca. P. citri*’ has been identified from the following countries (see Table 1), but has not been reported in the United States.

**Table 1.** Countries where ‘*Ca. P. citri*’ is known to occur

Region	Country	Reference/Note
Africa	Ethiopia	Melesse, 2009
Africa	South Africa	Botti and Bertaccini, 2007
Africa	Sudan	Tahir et al., 2017
Africa	Uganda	Arocha et al., 2009
Asia	China	Li and Chen, 2018
Asia	India	Ranebennur et al., 2023
Asia	Indonesia	Harling et al., 2009
Asia	Iran	Amirmijani et al., 2020
Asia	Japan	Naito et al., 2007
Asia	Jordan	Abu Alloush et al., 2023
Asia	Lebanon	Choueiri et al., 2005
Asia	Myanmar	Win et al., 2012
Asia	Oman	Al-Sadi et al., 2012
Asia	Pakistan	Khan et al., 2023
Asia	Taiwan	Liao et al., 2023
Asia	Thailand	Hodgetts et al., 2008

Asia	Turkey	Akkurak et al., 2022
Asia	United Arab Emirates	Garnier et al., 1991
Asia	Vietnam	Hoat et al., 2015
Europe	Italy	Parrella et al., 2008
Europe	United Kingdom	Reeder et al., 2010
North America	Cuba	Acosta et al., 2009
North America	Mexico	Carlos Ochoa-Sánchez et al., 2009
Oceania	Australia	Lee et al., 2010
Oceania	Fiji	Hodgetts et al., 2008
Oceania	New Caledonia	Davis et al., 2006
Oceania	Solomon Island	Davis and Tsatsia, 2009
Oceania	Tonga	Davis et al., 2006
Oceania	Vanuatu	Davis et al., 2006
Oceania	Wallis and Futuna	Davis et al., 2005
South America	Bolivia	Arocha et al., 2010
South America	Brazil	(Mafia et al., 2008; Queiroz et al., 2016; Silva et al., 2014)

## Pest Importance

This phytoplasma causes one of the most important diseases of key lime in the Middle East and India (EPPO, 2025). It could pose a serious threat to susceptible citrus hosts if it were established in the United States.

The effects of this pathogen are well-documented. In Oman, cultivated areas of key lime (*Citrus aurantifolia*) were reduced 50% between 1990 and 2006, mainly due to WBDL (Al-Yahyai et al., 2010). Infected trees eventually decline and collapse over 3 to 8 years (Bové et al., 2000). Disease resistant varieties are not currently known (Raheb et al., 2025).

'*Ca. P. citri*' is listed as a quarantine pest in 41 countries, including Argentina, Bahrain, China, Iran, Israel, Japan, Jordan, Morocco, Serbia, Switzerland, Tunisia, Turkey, United Kingdom, Uruguay and member countries of the European Union under its synonym, '*Ca. P. aurantifolia*' (EPPO, 2025). If the phytoplasma were found in the United States, potential trade impacts with these countries are possible. Although, the phytoplasma is already established in some of these countries (see [Known Distribution](#)).

## Pathway

'*Ca. P. citri*' is most likely to enter the United States through infected propagative materials (rootstocks, cuttings, and other grafting materials). *Citrus* is NAPPPRA (Not Authorized Pending Pest Risk Analysis) for all plant parts except seeds (USDA, 2025). To date, there is no evidence that '*Ca. P. citri*' moves into seeds or that it is seed transmitted (Faghihi et al., 2011).

While the introduction of infected insect vector *Hishimonus phycitis* into the United States might be a potential pathway, we found no evidence that '*Ca. P. citri*' can be transmitted vertically from mother to offspring, and the retention time of the phytoplasma within the vector is uncertain. *Diaphorina citri*, the Asian citrus psyllid, can also vector

the phytoplasma (Queiroz et al., 2016) and is present in the United States, but areas where this pest is present are quarantined to prevent the spread of citrus greening, which is the primary citrus disease vectored by ACP.

Use the [\*\*Agricultural Commodity Import Requirements\(ACIR\) manual\*\*](#) to determine 1) if host plants or material are allowed to enter the United States from countries where the organism is present and 2) what phytosanitary measures (e.g., inspections, phytosanitary certificates, post entry quarantines, mandatory treatments) are in use. This online manual provides a single source to search for and retrieve entry requirements for imported commodities and is updated regularly.

## Potential Distribution within the United States

For 'Ca. P. citri' to establish and spread in the United States, the phytoplasma, a vector, and a susceptible plant host would all need to be present. The primary vector, *Hishimonus phycitis*, is not currently present in the United States. The other vector, *Diaphorina citri*, is present in the Southern U.S., including Arizona, Texas, and parts of California, Puerto Rico, and the U.S. Virgin Islands. But, it is unlikely to influence the distribution of this pathogen because it is highly managed where it occurs to prevent the spread of citrus greening. Hosts of 'Ca. P. citri' are primarily grown in Florida and also grown in other southern states (NRCS-USDA, 2026).

## Survey and Key Diagnostics

### **Approved Methods for Pest Surveillance\*:**

For the current approved methods and guidance for survey and identification, see Approved Methods for Pest Surveillance (AMPS) pest page on the CAPS Resource and Collaboration website, at <https://approvedmethods.ceris.purdue.edu/>.

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## Versions

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