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Lesion Mimics in Mule Palm (× *Butyagrus nabonnandii*)[1]

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Introduction

Palms (Arecaceae) are flowering plants with varied growth forms ranging from climbers to tree-like plants found across diverse habitats. Approximately 2,600 palm species have been described taxonomically (Baker and Dransfield 2016), along with 114 natural hybrids (Henderson 2022). Some palm species naturally hybridize with other species, whereas a few species can be artificially hybridized to produce new morphotypes. Mule palm (× *Butyagrus nabonnandii*) is one example of an artificial hybrid that is becoming popular as a landscape ornamental because of its appearance and cold hardiness. However, hybridization among different species could lead to unintended outcomes, including lesion mimics. A lesion mimic phenotype, diagnosed based on the spontaneous appearance of leaf spots, was identified in mule palms growing across multiple farms in central and south Florida. As leaf spots are one of the most common symptoms observed during disease or nutritional deficiency, the detection of lesion mimics can sometimes be challenging. This publication documents a simple method to identify lesion mimics in palms. Correct diagnosis of lesion mimics would limit unnecessary applications of fungicides or fertilizers.

Mule Palms

The mule palm (× *Butyagrus nabonnandii*) traces its origin to the controlled crossbreeding efforts of Paul Nabonnand, a French nurseryman, during the late nineteenth century (Tournay 2009). Mule palm is a hybrid that results from an intergeneric cross between pindo palm (*Butia capitata*) × queen palm (*Syagrus romanzoffiana*), both members of the plant tribe Cocoseae, subtribe Butiinae. Rediscovered almost a century later in the United States (Wilcox et al. 1990), mule palms are sterile, producing neither fertile flowers nor fruit. In fact, the name mule palm comes from mule, the sterile hybrid resulting from a cross between a donkey and a horse.

Characterized by the intriguing blend of its parent species, mule palms exhibit a fusion of a queen palm's graceful fronds and the robust, silver-blue foliage of a pindo palm. Mule palms exhibit phenotypic variability, with heights ranging from 20 to 40 feet. Besides their aesthetic appeal, mule palms are fast-growing, cold tolerant down to 10°F–14°F, and drought resistant, thus making them a sought-after choice for landscapers and homeowners. While the resistance of mule palms to many common palm diseases remains unknown, they are susceptible to fusarium wilt, phytoplasma diseases, and nutritional deficiencies, emphasizing the importance of proactive care and vigilant monitoring to ensure their health and vitality.

Mule Palm Decline

A 2021–2022 survey of five palm nurseries across central and south Florida, with a cumulative area of about 1,800 acres, revealed that growers were facing challenges in maintaining a healthy stand of mule palms. Leaf spots were

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observed on multiple fronds, giving some mule palms an overall yellowish appearance (Dhillon et al. 2024). These palms showed a decline in vigor compared to adjacent healthy palms, and the symptomatic mule palms eventually withered and died. This decline in health and subsequent mortality was restricted only to mule palms, with a high cull rate of more than 20% recorded by growers.

Approximately 450 container-grown mule palms were surveyed, and leaf spots were identified on 29% of the three-year-old mule palms kept in full sun while growing in 15-gallon pots (Dhillon et al. 2024). This observation matched the high cull rate reported by growers for field-grown mature palms.

The declining mule palms were located randomly in the field without any apparent spatial pattern. Additionally, the fronds on adjacent lesion-free mule palms remained healthy, indicating that necrotic leaf spots were not spreading. The inconsistent distribution of symptomatic mule palms in the field and the lack of spread suggested that a pathogen was not responsible for these leaf spots on mule palms. Repeated fungicide and fertilizer applications by growers failed to improve the health of both container- and field-grown mule palms, suggesting that neither disease nor nutritional deficiency was responsible for causing mule palm decline.

Lesion Mimics

This unique phenomenon where disease-like symptoms are spontaneously observed even in the absence of a pathogen is known as "lesion mimic" (Figure 1). In other words, a "lesion mimic" plant resembles or mimics the appearance of a diseased plant through the presence of chlorotic and necrotic leaf spots. Lesion mimics often result from genetic abnormalities that disrupt normal cellular functions, leading to cell death. As the cells die on a lesion mimic plant, a spotting pattern appears that is similar to leaf spots observed during a pathogen attack. The appearance of lesion mimics is not limited to palms and has been reported in several other crops such as maize, rice, barley, wheat, soybean, tomato, brassica, cotton, pepper, and potato (Bruggeman et al. 2015; Freh et al. 2022).

In a lesion mimic plant, the appearance of lesions is often developmentally regulated, that is, as the leaf emerges and matures, so do the lesions. A similar pattern was observed in lesion mimic mule palms. A newly emerged frond did not show any lesions. On young fronds, lesions were observed as small water-soaked flecks, and as the fronds got older, the lesions turned chlorotic and necrotic. On mature mule palms with multiple fronds, an increase in lesion number and size was consistently observed on older fronds at the base of the canopy, as compared to younger fronds closer to the spear leaf.

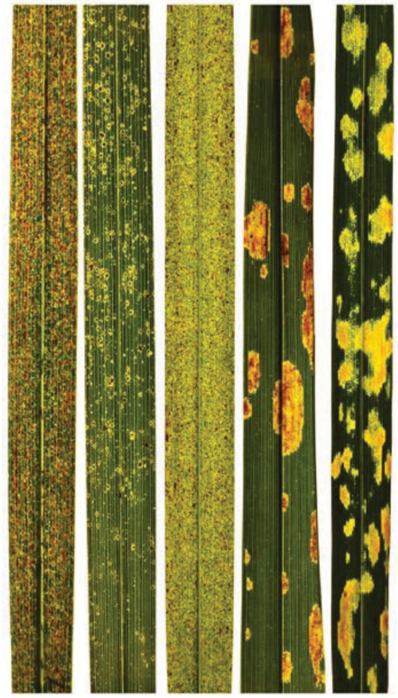

Figure 1. Variation in lesion mimic phenotype observed in mule palms. Leaflets displaying lesions of various colors, shapes, sizes, and leaflet coverage. From left to right: the first and third leaflets show small chlorotic and necrotic lesions covering the entire leaflet; the second leaflet has lesions with a necrotic center and chlorotic halo; and the fourth and fifth leaflets have lesions that appear as splotches.
Credits: Braham Dhillon, UF/IFAS

Not all lesion mimic palms look alike as the leaf spots may vary by color, size, density, and growth type (Figure 1). In some cases, the leaf spots may continue to grow, merge, and produce a blighted appearance. In other cases, the leaf spots will stop growing after reaching a certain size but continue to change in color from yellow (chlorotic) to brown (necrotic), covering the leaves with yellow and brown flecks.

Factors Affecting Development of Lesion Mimic Phenotype

The lesion mimic phenotype can be influenced by the genetic makeup of the plant. Mule palms result from "wide hybridization," a cross between individuals belonging to different genera, *Butia* × *Syagrus*. The resulting progeny carry different combinations of genes coming from the two parents. It is equally likely that the new gene combinations may be beneficial or detrimental to the health of the progeny. Any genetic combinations that negatively affect cell viability can cause cell death and give rise to spontaneous leaf spot development, as seen in lesion mimic individuals.

Leaf spot development in lesion mimics can be regulated by environmental factors like light and temperature (Johal et al. 1995). The role of light in the development of lesion mimic phenotype is likely related to the accumulation of reactive oxygen intermediates (ROI) produced during photosynthesis (Dangl et al. 1996). Normally, plants are equipped to handle ROI production and maintain homeostasis. However, genetic rearrangements during wide hybridization can reduce the plant's ability to control ROI production, causing cell death and leading to lesion mimic phenotype.

Leaf Spots, Diseases, and Nutritional Deficiencies

Leaf spots and blights on palms are usually associated with fungal diseases or nutritional deficiencies. Leaf spots during fungal infections often start as small water-soaked lesions that may be randomly scattered across palm fronds. Leaf spots can vary in color, often appearing as dark brown, black, red, or yellow spots, and sometimes may be surrounded by a halo of a different color. The size of the lesions is predominantly determined by the fungal pathogen that initiates the infection. Fungi like *Calonectria* cause leaf spots that continue to grow and merge, giving the palm a blighted appearance (Yu and Elliott 2013). Other fungi commonly isolated from leaf spots on palms are *Bipolaris*, *Cercospora*, *Colletotrichum*, *Gliocladium*, and *Pestalotiopsis* (Elliott 2006). Leaf spots may cause mortality in seedling and juvenile palms but are rarely lethal on larger palms.

Nutritional deficiencies can also lead to leaf spots in palms. Nutrient deficiency symptoms caused by potassium (K) are most likely to be confused with lesion mimic phenotype. Initial symptoms of K deficiency appear on older leaves as translucent yellow-to-orange, black, or necrotic spots (Figure 1; Broschat 2011). At later stages, symptoms progress to burning on leaf tips and along leaf margins. If not managed, K deficiency can cause complete scorching of the leaves, eventually leading to death of the palm.

Testing for Lesion Mimics

As light is a trigger for lesion mimic development, one way to establish if the mule palm has lesion mimic phenotype is to move it away from direct sunlight. However, this is especially challenging when working with mule palms growing in the field or installed in the landscape. An easy alternative is to cover a subset of leaflets with a wrap to exclude sunlight and keep them in complete darkness. In the absence of sunlight, true lesion mimic plants should fail to develop leaf spots.

Select the youngest fully open frond that is free of any leaf spots. Take a 5-inch-wide piece of aluminum foil, wrap it around a leaflet close to the rachis, and fold the four edges to ensure that the foil does not slide out. The foil cover will limit any sunlight from reaching the leaflet. Depending on the sunlight intensity (summer or winter) and growth of palms, leave the foil wrapped on the leaflet for 3–4 months. Upon removing the foil, if the covered part of the leaflet is found to be free of lesions even though the adjacent section has lesions (Figure 2), it would indicate that the mule palm is a lesion mimic.

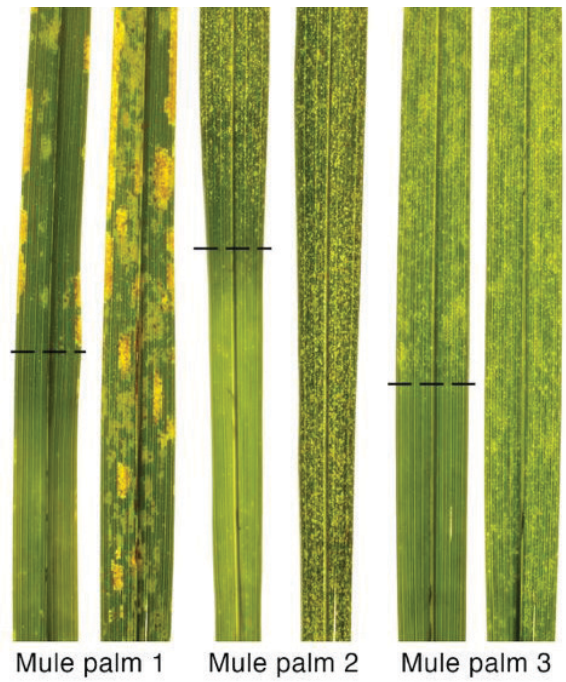

Figure 2. Exposure to sunlight leads to the formation of lesion mimics in mule palms. Three pairs of leaflets adjacent to each other on the rachis were selected from different mule palms. In each pair, the leaflet on the left was partly covered with aluminum foil and the leaflet on the right was completely exposed to sunlight. The top section of the leaflet exposed to sunlight showed lesion development, while the covered bottom section not exposed to sunlight failed to develop lesion mimic phenotype. The dotted line marks the boundary between the two sections.
Credits: Braham Dhillon, UF/IFAS

Why It Is Important to Diagnose Lesion Mimics

Since the appearance of lesions indicates a risk to plant health, an accurate diagnosis is necessary for choosing the correct treatment method. If the lesions are caused by pathogens or nutritional deficiencies, the affected palms can be treated with fungicides or nutrient supplements, respectively. However, this does not apply to lesion mimics because they are caused by genetic abnormalities, making external treatments ineffective. Therefore, accurate diagnosis is crucial to avoid unnecessary interventions and reduce expenses.

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