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Opinion

The Suspected Presence of Scab as a Potential Risk for Sustainable Pecans Production in Northern Mexico

César Guigón-López *, Jorge Ramírez-Chacón and Edel Torres-Torres

School of Agricultural and Forestry Sciences, Autonomous University of Chihuahua, Km 2.5 Carretera Delicias-Rosales, Delicias 33000, Chihuahua, Mexico; jeramire@uach.mx (J.R.-C.); edtorres@uach.mx (E.T.-T.)

* Corresponding author. E-mail: cguigon@uach.mx (C.G.-L.)

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ABSTRACT: Preliminary observations show that scab-like symptoms are present in pecan orchards in southern Chihuahua, Mexico. However, its presence has gone unnoticed by growers, who attribute the damage to zinc deficiencies. This disease can cause significant damage to trees and may represent a potential risk for pecan production. Two fungi were frequently isolated from the affected trees, *Cladosporium*-like fungus and *Alternaria*-like fungus, making it urgent to identify them using molecular techniques. The role of these fungi in the development of the disease—which commonly is attributed to *Cladosporium* spp.—should be determined through pathogenicity tests. The incidence and severity of the disease across the various growing regions must be assessed, and crop losses must be calculated. Research into disease epidemiology is also important for developing integrated management strategies that emphasize biological control and predictive systems.

Keywords: Sustainable agriculture; Pecan diseases; *Cladosporium*; *Alternaria*

1. Introduction

For a long time ago, in the United States, scab poses significant risks to pecans production [1,2]. In different production areas in the southern United States and northern Mexico, it has generally been believed that scab is caused by *Cladosporium caryigenum* G. Winter (synonym: *Fusicladium effusum*). In the United States, it is considered the most significant disease affecting pecan trees. However, Walker [3] found that at least three species (*C. cladosporioides*, *C. pseudocladosporioides*, and *C. subuliforme*) cause pecan scab in Brazil. In Mexico, there are no reports on its distribution and prevalence in pecan-producing areas, however, over the past five growing seasons, trees with foliage damage—typically associated with zinc deficiency—were observed in various pecan orchards in Chihuahua, in northern Mexico. Although the exact distribution and extent of the problem have not yet been determined, we have been detecting these symptoms since 2011 in the pecan-producing areas of Jiménez, Villa López, and Valle de Allende in southern Chihuahua.

This disease affects stems, branches, leaves, and developing nuts, causing yield reductions. If the disease is not controlled, entire crops can be lost during periods of prolonged rain or dew in other pecan-

producing regions, where it is a major constraint on production [4–6]. The aim of this Opinion article is to alert of new disease in the region based on preliminary observations. Here, we present observed facts, preliminary interpretations, and future research needs.

2. Early Observations

The first inspections were conducted at the request of some affected farmers, in affected trees, the symptoms are initially characterized by the presence of black or olive-colored spots on the foliage or on the young nuts (Figure 1A–E). These spots often merge to form larger, irregular patches. Lesions on leaves reduce photosynthesis and cause defoliation. In defoliated trees, growth, vigor, and nut production are reduced the following year. Severe infections can lead to the loss of the current year's growth. In several orchards, it has been observed that infections on petioles often spread to the smallest branches, causing terminal shoots to dry out completely because necrosis in the branches leads to a lack of water and nutrients. When shucks and nuts are infected, they develop dark lesions and take on an oily appearance.

Figure 1. Symptoms observed on pecan trees. (**A**) defoliated trees. (**B**) black or olive-colored spots on leaflets. (**C**,**D**) Infections on leaves and petioles often spread to the smallest branches, causing terminal shoots to dry out completely. (**E**) dark lesions in shucks. (**F**) Microbiological cultures in Petri dishes and microscopic images of the isolated fungi (**G**) *Cladosporium*-like and (**H**) *Alternaria*-like. Note that these symptoms are not diagnostic and may overlap with other leaf diseases.

Afterwards, in the spring and summer of 2024–2025, a survey was conducted in various pecan-growing areas in the south-central region of the state of Chihuahua, in northern Mexico. The sampling was designed based on the availability of cooperating farmers. The orchards were selected based on the willingness of their owners and because they exhibited scab-like symptoms. A zigzag path was followed through each orchard, and samples were collected from five trees. From each tree, samples of at least five units of each type—leaves, twig fragments, and affected fruit—were collected in each of the four cardinal orientations (north, south, east, and west). The samples from each tree were grouped together. Since this was a targeted sample, incidence and severity were not assessed on this specific occasion. Samples were analyzed using conventional microbiological methods, such as PDA cultures, purification of isolates using the hyphae tip technique, and macroscopic and microscopic morphological characterization. In the spring, it was common to see colonies developing in the cultures, ranging in color from dark olive to brown, with septate, brown, erect, simple, or branched mycelium. The conidia were brown, obovate, and bicellular; a few were clavate

or elongated and had more than two cells (Figure 1F,G). These characteristics coincide with the description of a fungus similar to the genus *Cladosporium*. In the summer, in addition to *Cladosporium*-like fungus, another very similar dark mycelium was detected, with dark conidiophores, mostly simple, determinate, or sympodial; conidia dark, almost always with transverse and longitudinal septa; shape obclavate to elliptical or ovoid. This mycelium exhibits characteristics similar to those of fungi of the genus *Alternaria*. Nevertheless, given that neither molecular identification nor pathogenicity testing has been performed, it is not possible to definitively determine the disease etiology.

According to the data in Figure 2, the disease was frequently detected in symptomatic samples from multiple municipalities in the south-central Chihuahua pecan-producing region. We sampled 60 pecan orchards, mainly in Delicias and Rosales, which were the municipalities that provided the most samples, followed by Camargo, Meoqui, and Saucillo. All samples analyzed tested positive for *Cladosporium*-like fungus, while *Alternaria*-like was a fungus with an intermittent presence, commonly after mid-July.

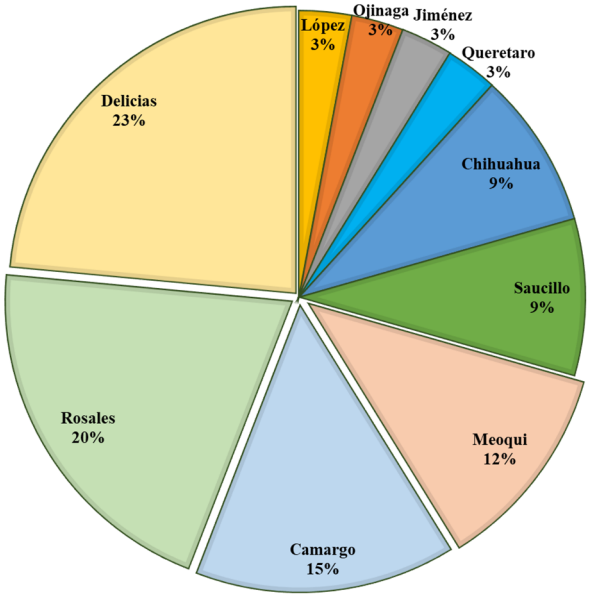

Figure 2. Municipalities affected by scab-like symptoms in the south-central region of Chihuahua (Mexico). The presence of disease was confirmed in all samples analyzed (n = 60 pecan orchards). The percentage values refer to the sample distribution by municipality. Querétaro is a state located in central Mexico, from which samples infected with pecan scab were received.

3. Preliminary Interpretations and Research Needs

In a region of great economic and social importance, such as south-central Chihuahua, a pecan tree disease similar to pecan scab was frequently detected. Preliminary observations show scab-like symptoms on various above-ground parts of the trees (leaves, petioles, twigs, and nuts), indicating the disease poses a potential risk to pecan production. Therefore, it is important for everyone involved in pecan production to determine whether the cause of the problem is biological or nutritional, so that it can be properly addressed and resources can be allocated to its study and control. In this regard, the incidence and severity of this disease in the various producing regions must be determined, and crop losses must be estimated. The presence of the *Cladosporium*-like fungus is significant, given international reports that identify *Cladosporium* spp. as one of the agents that cause disease in pecans. The presence of an *Alternaria*-like fungus should be viewed with caution. *Alternaria* is not mentioned in the United States or Brazil, but given its frequency in the analyzed samples, it is advisable to determine its role in the progression of the disease or in the severity of symptoms. The *Alternaria* species are ubiquitous in the environment, acting as saprotrophs, human allergens, and plant pathogens [7]. Therefore, it is important to use molecular techniques to accurately identify the *Cladosporium*-like and *Alternaria*-like fungi present in different

pecan-producing regions. Pathogenicity tests should be conducted to determine how these fungi, both individually and in combination, contribute to the development of the disease. The epidemiology of the disease will be studied, and integrated management strategies will be designed with an emphasis on biological control and forecasting systems that enable the rational use of chemical fungicides. These actions will help prevent the problems caused by other similar diseases in other pecan-producing regions around the world. However, to achieve this, it is essential to involve farmers, the government, and companies, as well as to allocate funds for research into the problem and its solution.

In conclusion, pecan scab-like disease is present in Chihuahua, Mexico, affecting the above-ground parts of trees such as leaves, twigs, and nuts. Without suitable diagnosis and management, this disease can represent a potential risk to pecan production. Two fungi, *Cladosporium*-like and *Alternaria*-like, were isolated from the affected parts; however, further research is needed to confirm the etiology of the disease and to assess its incidence, severity, and the magnitude of crop losses in different growing regions. It is also necessary to study the disease epidemiology and its integrated management.

Statement of the Use of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this manuscript, the authors used ChatGPT in order to draw the graphical abstract. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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