Pecan diseases in South Africa

By: Dr Gert J. Marais

A 5-year collaborative project is currently conducted between SAPPA and the University of the Free State that was initiated at the beginning of 2017. The past year was definitely the most challenging with COVID-19 that has significantly influenced the logistics and progress of the project. Due to the lockdown in March, two field trips, including a trip to the Eastern Cape and North West provinces, had to be cancelled. In addition, the availability of chemicals in the laboratory, and access of students to the campus was halted for at least five months of 2020. Some students, living outside the Free State Province and neighbouring countries, could also not get to campus during this period. Due to the fact that much of the research, such as pathogenicity trials, is seasonal, a number of tasks in the student projects had to be postponed to the next season. Although these challenges have placed tremendous pressure on the deliverables of the project in 2020, some student studies have been concluded. This report therefore focuses specifically on the findings of these studies.

One of these included an MSc study on the fungus complex, *Cladosporium cladosporioides*, and their role in the development of scab in South Africa. What was interesting about this study is that scab samples from all the production areas in South Africa have not once produced an isolate of the well-known scab fungus from the USA, nl. *Venturia effusa*. However, of the 63 isolates studied, all have shown to belong to the species complex known as *Cladosporium cladosporioides*. This emphasised that the pecan scab fungus in South Africa is not the same as found elsewhere in the world. Genetic analyses of the South African isolates indicated that they belong to at least twelve different fungal species, of which seven were previously unknown to man. It was also found that all of these fungi are new reports on pecans, and 11 of the 12 species are newly reported from South Africa. In addition, the most dominant fungus (about 50% of the isolates) that was isolated from scab areas in South Africa is currently only known as *Cladosporium* sp. 5 due to its novelty, and needs to be officially described. This fungus was tested for its pathogenicity and results indicated that it is indeed capable of causing scab in pecans. The number of different *Cladosporium* species associated with pecans was astonishing and the full impact of these fungi in pecan scab is yet to be determined.

The question is: What does this all mean to the pecan industry in South Africa? For one, we now have confirmed that the causative agent of pecan scab in South Africa is not *Venturia effusa*, but rather a newly discovered fungus unknown to science (*Cladosporium* sp. 5). This means that the pecan industry in South Africa has unique challenges in combatting scab, and best practices in the USA does not necessarily guarantee success under South African conditions. We still know little about the ecological, physiological, and pathogenic capabilities of these twelve *Cladosporium* species and need further attention. Typical scab symptoms on pecan

nuts and leaves were only observed in the eastern parts of South Africa, including Limpopo, Mpumalanga, Kwazulu-Natal and the Eastern Cape. However, *Cladosporium* species were found in all the pecan production areas of South Africa. There is a tendency to belief that the occurrence and distribution of scab is likely associated with the difference in environmental conditions between the eastern and the western parts of South Africa. If this is the case, producers in the western parts of the country should be aware that environmental changes could change the occurrence of scab, as *Cladosporium* species are found country-wide. What is astonishing is the wide variety of *Cladosporium* species isolated from scab material, but even the genetic diversity among individual isolates of *Cladosporium* sp. 5. This is concerning as members of the *Cladosporium cladosporioides* species complex are not known to reproduce sexually. The importance of this is that sexual reproduction is a way of an organism to accomplish genetic diversity to adapt to changes in the environment, where the offspring is genetically different from the parents. This ultimately leads to the diversification of the fungal species, which is what we observe in *Cladosporium* sp. 5. Although the sexual phase of the life cycle of this fungus has not yet been seen, the genetic diversity within this species suggests that it likely exists. This makes this fungus unpredictable in future and treatments that currently control scab could become obsolete as the fungus continues to evolve.

Scab symptoms on pecan nuts have shown to be mostly superficial or just underneath the outer layers of the husk. The expansion of the nut, especially during the early stages of development, could be negatively influenced, and can lead to nut drop. However, scab infections later in the second halve of the season has a lesser impact on yield loss. Studies in the USA on the dispersal of *Venturia effusa* indicated that wet conditions and high humidity stimulate the growth and production of spores. But it is only during dryer periods that the spores are released and become airborne. This is also likely the mode of action in members of *Cladosporium*, as their morphological characteristics are very similar to *V. effusa*. It is therefore more important to control scab during the first halve of the growing season, that, according to literature, could be done through the use of fungicides containing tin such as triazole or propiconazole, as well as azoxystrobin, chlorothalonil, or fentin hydroxide.

A second MSc project that was concluded in 2020 include the dieback fungus, *Neofusicoccum parvum*. This fungus was identified at the beginning of the 5-year project as one of the key issues in pecans. Results showed that *N. parvum* was isolated from dieback branches, but also from apparently healthy plant tissue. This indicates that this fungus as an endophyte in pecans that can be dormant without causing disease symptoms. These types of fungi are known to become active as pathogens when plants become stressed, either due to environmental challenges or damage. Pathogenicity tests with *N. parvum* showed that this fungus is capable of causing dieback of pecan branches and black blotch on the nuts.

Surveys on dieback branches also indicated that other fungi belonging to *Lasiodiplodia*, *Botrysophaeria* and *Dothiorella* are regularly associated with dieback in pecans. In total, 12 different species were identified based on genetic analyses.

However, further investigation is needed to determine whether these fungi could also be responsible for dieback in pecans.

The control of dieback due to *N. parvum* could prove to be difficult. It is well known that other factors besides this fungus could also be responsible for dieback in pecans. These include drought, frost, high temperatures, sun damage, physical damage, and suboptimal fertiliser applications. The best indication to find that dieback is caused by a fungal infection, is to cut through the dead or dying branch, and observe whether brown discolourations are visible in the sapwood. Normally these lesions are off-centred. It is suggested that dieback branches be regularly removed from orchards to keep the possible inoculum of dieback fungi low. Currently, there is no fungicides registered on pecans for these fungi, but initial laboratory trials in 2017 indicated that products containing boscalid and pyraclostrobin, propyconazole, and fentin hydroxyde could inhibit growth of *N. parvum* on contact. Azoxystrobin also showed inhibition to some extent. However, the best option to stop further infection is to physically remove the dead branches and cut back into the living tissue until no brown lesions are observed.

A number of postgraduate studies are currently still ongoing, focussing on specifically the overall decline of pecans. These include the role of *Alternaria* in dieback and black spot, *Fusarium* species as causative agents of root rot and stem rot, Ophiostomatoid fungi in stem rot, as well as basidiomycetous fungi as white and brown rot fungi in pecans. In addition, an MSc study is investigating the metabolites of different pecan cultivars that could lead to fungal resistance. A number of these projects are envisaged to be concluded in 2021.

Research thus far indicated that diseases of pecans in South Africa are in many cases new and novel, and are more complex than earlier expected. Experience have shown that for example scab in pecans is likely a disease complex, meaning that more than one fungal pathogen is responsible. This is also evident in overall decline where different fungal species are found in different affected trees. We are only starting to unravel the complexity of these diseases, which need further support from the industry to eventually get to a point where educated approaches for disease management can be implemented.

Figure 1: Pecan scab on nuts caused by *Cladosporium cladosporioides*.

Pecan scab on leaves caused by *Cladosporium cladosporioides.*

Figure 3: Dieback associated with *Neofusicoccum parvum*.

Figure 4: Fungal infection in a pecan stem from a tree that showed overall decline.