Evaluation of maize ear rot pathogens with HSI

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Diplodia ear rot caused by Stenocarpella maydis, Fusarium ear rot caused by Fusarium verticillioides and Gibberella ear rot caused by the Fusarium graminearum species complex are the major maize ear rot diseases occurring in South Africa. These pathogens constitute the greatest economical concern to farmers; they result in yield losses and grain quality reduction through discoloured kernels, and production of mycotoxins (Boutigny et al., 2012; Schoeman & Flett, 2012). It is of utmost importance to study these pathogens to improve detection methods; however, current methods are labour intensive, time consuming and requires skilled personnel. This work aimed to examine maize fungal pathogens with HSI.

Isolates of Fusarium spp. and Stenocarpella spp., most commonly associated with maize ear rot were provided by the Department of Plant Pathology, Stellenbosch University, South Africa. The pathogen isolates were plated on growth media in glass Petri dishes. Each isolate was plated in triplicate, and incubated at 25°C for 9 days. Images were acquired with a SisuChema short-wave infrared (SWIR) pushbroom imaging system (Specim Spectral Imaging Ltd, Oulu, Finland) in the spectral range 920 – 2514 nm. Data were analysed with Evince v.2.7.0 (Prediktera AB, Umeå, Sweden), as well as MATLAB v.9.4.0 (The MathWorks, Massachusetts, USA) with PLS_Toolbox (Eigenvector Research Inc). Principal component analysis, with various pre-processing methods (None, SNV & Savitzky-Golay (SavGol) 2nd derivative), and multivariate curve resolution were used to decompose and explore the data.

PCA with or without pre-processing, revealed chemical differences within and between the fungal isolates as illustrated in score images. These differences were amplified with time, i.e. as the isolates aged. Examination of the mean spectra and PC loadings after SNV and SavGol [2nd derivative, 4th order polynomial & 15 pt smoothing] indicated variation primarily around bands associated with water/moisture (1450 & 1930 nm), protein (2180 & 2242 nm) and carbohydrates/starch (1090, 1360 & 2100 nm). This is expected since fungi are mainly comprised of these constituents and as the mycelium grows and ages, there is a change in carbohydrate (content or structure), moisture and protein. This was apparent in higher order components (PCs 4-6) and appeared as textured information. It has been reported that mycelia of the inner colony contain more cell wall substance (polysaccharides) than the outer regions (Yanagita and Kogane 1962).

MCR revealed similar results, however the concentration maps were often clearer than PCA score images. In addition, these maps were more textured illustrating the physical changes of the mycelium with time. These were due to the growing hyphae and possible spore formation. In addition, it is likely that these concentration maps indicated presence of mycotoxins. As fungi age, they tend to produce secondary metabolites known as mycotoxins. Pure spectral profiles indicated moisture, protein and carbohydrates to be the main chemical constituents in the fungal isolates.