



University of Venda

**Mathematical modelling of fungal
contamination of citrus produce along the
pre-harvest supply chain**

by

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Abstract

South Africa is one of the major exporter of the citrus produce to sophisticated markets such as the European markets. Unfortunately, its trading position was compromised when *Guignardia citricarpa* invaded and persisted in citrus produce growing regions. The epidemiological development of this pathogen has no harm to humans, but reduce fruits quality and quantity. As a result this negatively affects the farmers' income, diet supplier and the economy in general. Fresh produce has a natural mechanism of effectively protecting themselves against microbial contamination. However, inappropriate manipulation during the planting, harvesting, storage, processing, distribution, preparation or handling and abuse of temperature during storage or transportation increases the risk of microbial contamination of citrus produce along the supply chain. In most cases the quantity of the micro-organism contaminating the citrus produce may be very small but then grows with time in the presence of suitable conditions. In this study, three mathematical models are developed to study the transmission dynamics of *Guignardia citricarpa* at different levels and scales. The first model captures the dynamics of epidemiological aspects of Citrus Black Spot (CBS). The second model is an immunological model which deals with the within-host dynamics and the third model is the fusion of the immunological and epidemiological models. The mathematical properties of all models are studied to determine whether they are mathematically and epidemiologically well-posed. The basic reproduction number R_0 for all models are computed using the generation operator approach and the Jacobian matrix. If $R_0 < 1$, then the disease free equilibrium states of all models are locally and globally asymptotically stable, but if $R_0 > 1$ then the endemic equilibrium state is locally and globally asymptotically stable. Sensitivity analysis is done on the variation of their model parameters and finally the numerical simulation of the models is done to confirm the behaviour of the models with time. In all the models the results show that their reproduction number is more sensitive to changes in the recruitment rate parameters and the transmission probability. Hence, cleaning the orchard floor regularly, spraying susceptible fruits while they are still young and emphasise on the good agriculture practise can slow down the probability transmission rate.