A mathematical model of crop vector-borne epidemic with vital dynamics

Michael Chapwanya[1], Yves Dumont[1,2,3]
[1] University of Pretoria, Department of Mathematics and Applied Mathematics, Pretoria, 0002, South Africa
m.chapwanya@up.ac.za
[2] CIRAD, Umr AMAP, Pretoria, South Africa
[3] AMAP, Univ Montpellier, CIRAD, CNRS, INRA, IRD, Montpellier, France,
yves.dumont@cirad.fr

Keywords: Vector-borne disease; stability analysis; Hopf bifurcation.

Identifying key factors in the spread of vector-borne diseases is an essential step in designing control strategies. Among all plant diseases, vector-borne diseases are the most threatening because a large number of organisms are able to transmit plant pathogens. Also, compared to human or animal viruses, plant viruses have different and complex transmission ways, such that their control is more difficult. That is why it is important to study the interactions between the plant, the vector and the virus.

In this work, which is an extension of the work in [1], a crop vector-borne epidemic model with vital dynamics is investigated. The equilibria and the threshold of the model are determined according to the basic reproductive number $\mathcal{R}_0$. It is shown that the disease free equilibrium is globally asymptotically stable when $\mathcal{R}_0$ is less than unity. Moreover, when $\mathcal{R}_0 > 1$, the endemic equilibrium may lose (for a particular sub-interval) its stability through Hopf bifurcation leading to oscillatory solutions. This is proved analytically and supported by numerical simulations.

References

[1] M. Chapwanya and Y. Dumont, *On crop vector-borne diseases. Impact of virus lifespan and contact rate on the traveling-wave speed of infective fronts*, Ecological Complexity **In Press**.