Analysis of a Mathematical Model Arising in Plant Disease Epidemiology

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Abstract: Xylella fastidiosa (Xf) is a bacteria originating from the Americas, identified in Europe during the last decade when the Italian authorities reported the first outbreak of Xf in the south of the Apulia region in 2013. Several important crop diseases can be associated with Xylella fastidiosa, such as the Pierce's disease of grapevine, the plum leaf scald, the Citrus varie gated chlorosis, the phony peach disease, and as confirmed in Italy, Xf is the cause of olive quick decline syndrome, which dramatically brought the Apulia olive growing sector to its knees. So, we can see the importance of the knowledge on the dynamics of Xylella fastidiosa infection which is an essential element for the effective management of new foci.

In this communication, we study from the mathematical and numerical point of view a problem arising in vector-borne plant diseases. The model is written as a nonlinear system composed of a parabolic partial differential equation for the vector abundance function and a first-order ordinary differential equation for the plant health function. An existence and uniqueness result is proved using backward finite differences, and the regularity of the solution is also obtained ([1]). Using the finite element method and the implicit Euler scheme, fully discrete approximations are introduced. A discrete stability property and a main a priori error estimates result are proved. Finally, some numerical results, in one and two dimensions, are presented to demonstrate the accuracy of the approximation and the behaviour of the solution.

References:

[1] Bazarra, N., Colturato, M., Fernández, J.R., Naso, M.G., Simonetto, A., Gilioli, G.. Analysis of a Mathematical Model Arising in Plant Disease Epidemiology. Appl Math Optim 85, 19 (2022).