A Seasonal Stage-Structured Mathematical Model for *Flavescence Dorée* Disease Transmission in Grapevine

Nigussie A. Shiferaw, Ábel Garab, Attila Dénes
University of Szeged, Szeged, Hungary

Global grape production is projected to reach approximately 75 million metric tons in 2025. This production supports the wine, fresh fruit, and processed product industries, highlighting the necessity of understanding the transmission dynamics of vector-borne agricultural diseases to safeguard this economically significant crop. *Flavescence dorée* is a severe vector-borne phytoplasma associated disease of grapevines, transmitted between grapevines by the leafhopper vector *Scaphoideus titanus*. This study develops and investigates a stage-structured disease model that incorporates the developmental stages of the vector population and their role in disease transmission. The grapevine host population is partitioned into three epidemiological classes: susceptible, exposed, and infectious, while the vector population is in sequential developmental stages of *Scaphoideus titanus*: eggs, early-instar nymphs, late-instar nymphs, and adults. To account for seasonal weather variations and the behaviour of the vectors, we consider periodic transmission, birth and death rates. We assume a frequency-dependent biting rate, in which only infected adult vectors can transmit the virus, while both late-instar nymphs and adults can acquire the pathogen from infected grapevines. We calculate the basic reproduction number as the spectral radius of a linear operator and show that it serves as a threshold parameter for disease persistence. We also give some numerical simulations to assess the effect of varying key model parameters.