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Globally asymptotic stability in a delayed plant disease model

We consider the following system of delayed differential equations,

$$\begin{cases} \frac{dS(t)}{dt} &= \sigma\phi - \beta S(t)I(t-\tau) - \eta S(t), \\ \frac{dI(t)}{dt} &= \sigma(1-\phi) + \beta S(t)I(t-\tau) - (\eta+\omega)I(t), \end{cases}$$

which can be used to model plant diseases. Here $\phi \in (0,1]$, $\tau \geq 0$ and all other parameters are positive. The case where $\phi = 1$ is well studied and there is a threshold dynamics. The system always has a disease free equilibrium, which is globally asymptotically stable if $R_0 \triangleq \frac{\beta\sigma}{\eta(\eta+\omega)} \leq 1$ and is unstable if $R_0 > 1$; when $R_0 > 1$, the system also has a unique endemic equilibrium, which is globally asymptotically stable. In this paper, we study the case where $\phi \in (0,1)$. It turns out that the system only has an endemic equilibrium, which is globally asymptotically stable. The locally stability is established by the linearization method while the global attractivity is obtained by the Lyapunov functional approach. The theoretical results are illustrated with numerical simulations. This is a joint work with Chongwu Zheng.