Global stability of a mathematical model for a honeybee colony infested by Varroa mites, possible vectors of deformed wing virus

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We establish a new four-dimensional system of differential equations for a honeybee colony to simultaneously model the spread of Varroa mites among the bees and the spread of the deformed wing virus transmitted by the mites. The bee population is divided to forager and hive bees, while the latter are further divided into three comparments: susceptibles, those infested by non-infectious vectors and those infested by infectious vectors. The system has four potential equilibria. We identify three reproduction numbers that determine the global asymptotic stability of the four possible equilibria. By using Lyapunov functions and persistence theory, we show that the solutions always converge to one of the equilibria, depending on those three reproduction numbers. Hence we completely describe the global dynamics of the system.

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