Modeling of optimal phytosanitary policies in crops of economic importance in the state of Sonora.

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Contents

Figure: In the left we have tomato plant, in the right infected tomato plant.

Objetive

Model optimal phytosanitary policies for diseases in agricultural crops.

Figure: Alternative host plants.

Plant Model without control

Tomato Leaf Curl Virus Disease Using an Epidemiological Model

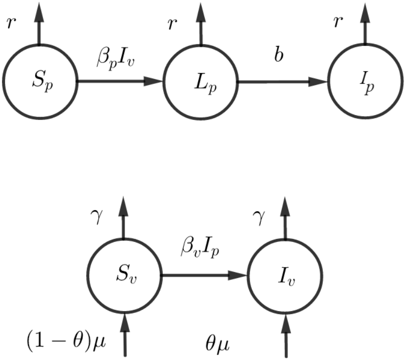

Figure: Diagram of dynamic in plants and vectors.

Consider the following ordinary differential equations:

$$
\begin{aligned}
\frac{dS_p}{dt} &= -\beta_p S_p I_v + r(L_p + I_p), \\
\frac{dL_p}{dt} &= \beta_p S_p I_v - bL_p - rL_p, \\
\frac{dI_p}{dt} &= bL_p - rI_p, \\
\frac{dS_v}{dt} &= -\beta_v S_v I_p - \gamma S_v - (1-\theta)\mu, \\
\frac{dI_v}{dt} &= \beta_v S_v I_p - \gamma I_v - \theta\mu.
\end{aligned} \tag{1}
$$

Computing the R_0 we have,

$$R_0 = \sqrt{\frac{\beta_v \mu b \beta_p}{r^2 (r+b)\gamma}}$$

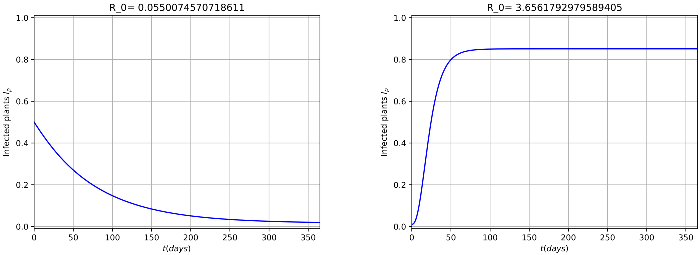

Figure: Evolution of infectious plants.

Plant Model with control

Tomato Leaf Curl Virus Disease Using an Epidemiological Model

The controlled system is the following:

$$
\begin{aligned}
\frac{dS_p}{dt} &= -\beta_p S_p I_v + (r+u_1)L_p + (r+u_2)I_p, \\
\frac{dL_p}{dt} &= \beta_p S_p I_v - bL_p - (r+u_1)L_p, \\
\frac{dI_p}{dt} &= bL_p - (r+u_2)I_p, \\
\frac{dS_v}{dt} &= -\beta_v S_v I_p - (\gamma+u_3)S_v - (1-\theta)\mu, \\
\frac{dI_v}{dt} &= \beta_v S_v I_p - (\gamma+u_3)I_v - \theta\mu,
\end{aligned}
\tag{2}
$$

With the cost functional:

$$\int_0^T \left[A_1 I_p(t) + A_2 L_p(t) + A_3 I_v(t) + c_1 u_1(t)^2 + c_2 u_2(t)^2 + c_3 u_3(t)^2\right] dt, \tag{3}$$

Case with one controls

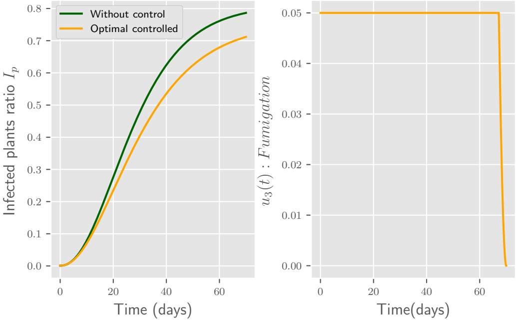

Figure: Evolution of infectious plants with one control, $u_3(t)$: Fumigation.

Case with two controls

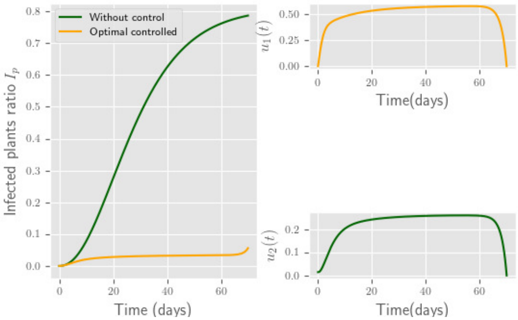

Figure: Evolution of infectious plants with two controls, $u_1(t)$: removed latent plants, $u_2(t)$: removed infected plants.

Case with three controls

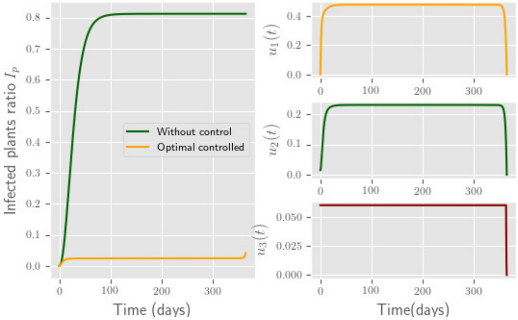

Figure: Evolution of infectious plants with three controls, $u_1(t)$: removed latent plants, $u_2(t)$: removed infected plants, $u_3(t)$: Fumigation.