

mm

40

60

80

100

120

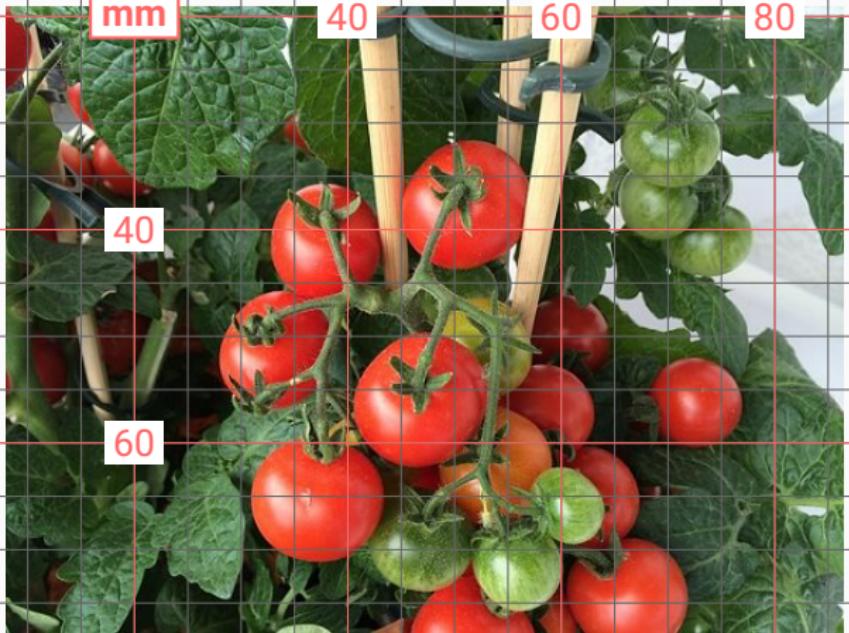
Modeling optimal control policies

in stochastic epidemic models

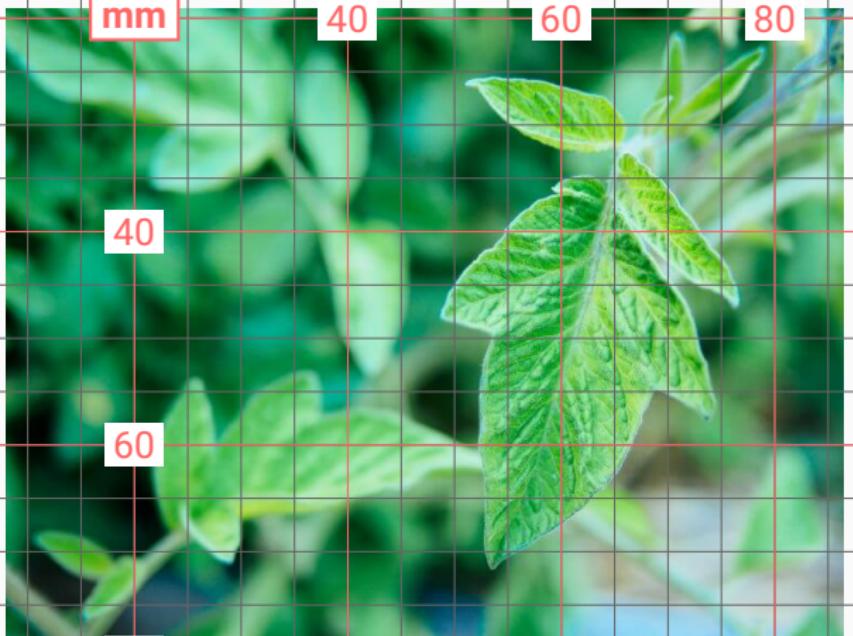
Saúl Díaz Infante Velasco

CONACYT-UNIVERSIDAD de SONORA

Tomato leaf curl virus disease (TYLCVD)



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- Tomato plants **infected early** are severely stunted and will **not produce fruit**
- Leaflets are small and yellowed with edges that curl upwards
- Flowers either do not develop or fall off
- When **older plants** are infected, fruit that is already forming ripens normally, but **no new fruit** is formed after the infection
- TYLCV can be confused with several other conditions such as tomato big bud, herbicide damage and phosphate or magnesium deficiency



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Spread

- **TYLCV** is spread by the insect silverleaf whitefly (Bemisia tabaci B biotype)
- Silverleaf whiteflies pick up the virus by feeding on infected host plants. The whiteflies then spread the virus to healthy plants which show the symptoms 10 to 21 days later
- Silverleaf whiteflies are common in many countries and feed on many types of plants



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Control

Cultural Control

- Physical barriers
- Planting dates
- Removal of infested plants
- Host plant resistance

Biological Control

- Parasitoids
- Predators
- Fungi

Insecticides

- pymetrozine
- zeta-cypermethrin / bifenthrin



Shun-xiang, R., Zhen-zhong, W., Bao-li, Q., and Yuan, X. (2001).

THE PEST STATUS OF BEMISIA TABACI IN CHINA AND NON-CHEMICAL CONTROL STRATEGIES.

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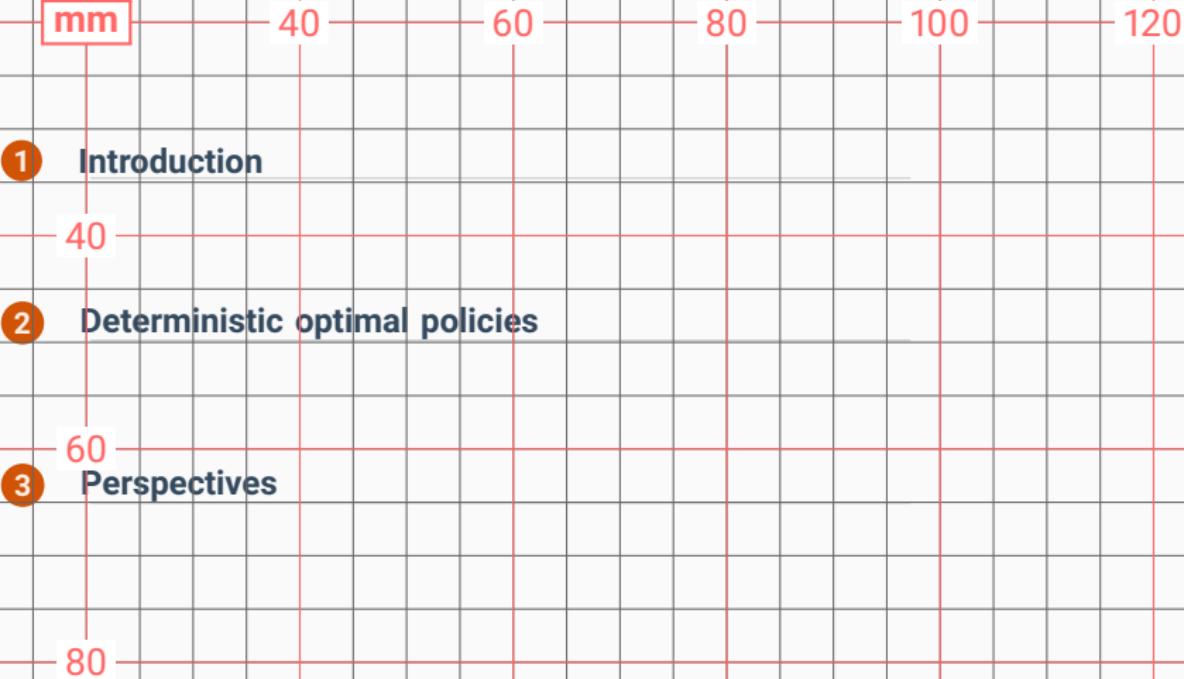


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$$\frac{dS_p}{dt} = -\beta_p S_p I_v + r(L_p + I_p)$$

$$\frac{dL_p}{dt} = \beta_p S_p I_v - b L_p - r L_p$$

$$\frac{dI_p}{dt} = b L_p - r I_p$$

$$\frac{dS_v}{dt} = -\beta_v S_v I_p - \gamma S_v + (1 - \theta)\mu$$

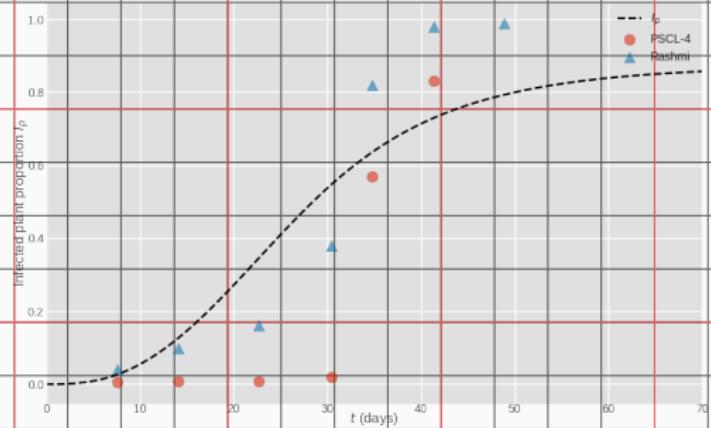
$$\frac{dI_v}{dt} = \beta_v S_v I_p - \gamma I_v + \theta\mu$$

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

$$DFE = (N_p, 0, 0, 0, \mu/\gamma)^\top$$

$$EE = (S_p^*, L_p^*, I_p^*, S_v^*, I_v^*)^\top$$

Par.	Value	Descrip.
β_p	0.1	latent rate
r	0.01	remove rate
$1/b$	0.075	time of latency
γ	0.06	vector die or depart rate
μ	0.3	immigration rate
θ	0.2	infected vectors arrival
β_v	0.003	vector infected rate



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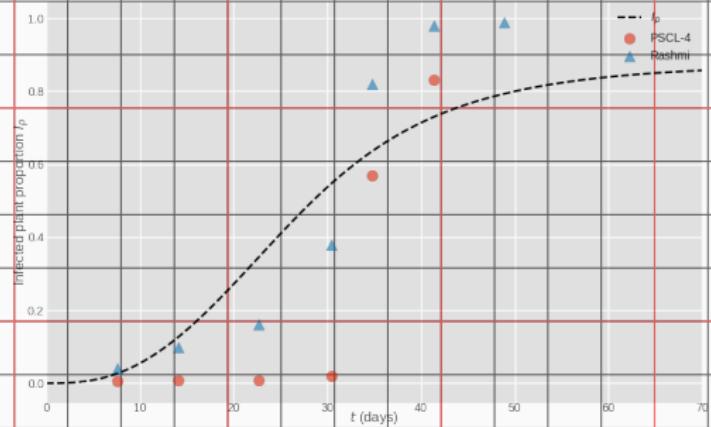
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Deterministic controlled dynamics

$$\frac{dS_p}{dt} = -\beta_p S_p I_v + \textcolor{blue}{r}(L_p + I_p)$$

$$\frac{dL_p}{dt} = \beta_p S_p I_v - b L_p - \textcolor{blue}{r} L_p$$

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$$\frac{dI_v}{dt} = \beta_v S_v I_p - \textcolor{brown}{r} I_v + \theta \mu$$

$u_1(t)$: Latent replanting

$u_2(t)$: Infected replanting

$u_3(t)$: Fumigation

$$80 \quad 100 \quad 120$$

$$\int_0^T \left[A_1 I_p(t) + A_2 L_p(t) + A_3 I_v(t) + \sum_{i=1}^3 c_i \frac{u_i^2}{2} \right] dt$$

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Deterministic controlled dynamics

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