Effect of Transmission Parameters on BXW Dynamics

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Outline

- Objective
- Introduction
- Model Formulation
- Results
- Conclusions
Objective:
Identify extrinsic measurable parameters which determine the prevalence of Banana Xanthomonas Wilt (BXW)

Specific Objectives:

- Obtain a threshold parameter for disease persistence
- Investigate the implication of different transmission parameters on endemic levels
- Determine the impact of combined cultural control practices on disease prevalence
Introduction:

• Banana is an important food crop and source of income to most farmers in the East African Region

• Banana Xanthomonas Wilt (BXW) caused by *Xanthomonas campestris* pv. *musacearum* threatens livelihoods of millions of farmers within the region

• First reported in Uganda and D.R. Congo in 2001. Later spreading to Rwanda, Tanzania, Kenya and Burundi

• Affects almost all cultivars causing both extreme and rapid impact to the community

• Spread by: Farming tools, use of infected sucker, mother to sucker (vertical transmission) and through inflorescence infection via the male bud by insects, bats and birds
Introduction C’td:

- Symptoms:
  a) Wilting of male bud and leaves
  b) Uneven and premature ripening of fruit
  c) Yellow ooze on the cross-section cut of the pseudostem

[Images of banana plants showing symptoms]

http://www.promusa.org/Xanthomonas+wilt
Model Formulation and Analysis
Model Formulation

Assumptions of the deterministic mathematical model:

1. At any given time, a selected farm has healthy, latently infected and infectious plants

2. Homogenous mixing assumes the rate of transmission is the same irrespective of the cultivar

3. Only healthy planting materials are used for replanting or replacement of rogued plants
Model Analysis:

Formulated a system of ordinary differential equations to:

- Determine a threshold value (basic reproduction number $R_0$)
  - The number of secondary infections that arise from introduction of a single infected plant or use of an infected machete in a fully healthy banana plantation

- Find equilibrium levels and their stability with and without vertical transmission

- Carry out numerical simulation using parameter values obtained from literature
Mathematical and Numerical Results
Mathematical Results:

1. The basic reproduction number:

\[ R_0 = \frac{\beta}{\delta} + \frac{a^2 bcm (k_1 + \varepsilon \delta)}{\Lambda_v} \]

2. In the absence vertical transmission,
   I. a disease free equilibrium is globally asymptotically stable whenever \( R_0 < 1 \)
   II. A unique globally asymptotically stable endemic equilibrium exist if \( R_0 > 1 \)

3. With Vertical transmission, the disease persist.
Numerical Results:  \( R_0 < 1, \theta = 0, \varphi = 0 \)

Fig 1: Plot for disease free equilibrium in the absence of vertical transmission given different initial conditions.
Numerical Result c’td: $R_0 > 1, \theta = 0, \phi = 0$

Fig 2: Plot for endemic equilibrium levels in the absence of vertical transmission given different initial conditions
Numerical Results c’td: $\theta \neq \phi \neq 0$

Fig 3: Plot for endemic equilibrium levels in the presence of vertical transmission
Numerical Results c’td

Fig 4: Plot for BXW prevalence with application of control measures at different rates
Conclusions:

1. In the absence of vertical transmission, disease eradication is possible.

2. Equilibrium levels are noted to be lower when there is no vertical transmission.

3. Intensive implementation of control practices in combination will eventually lead to eradication.
Thank you

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