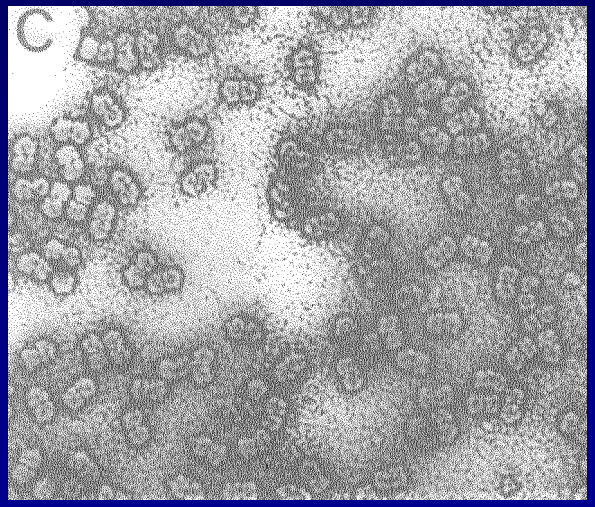
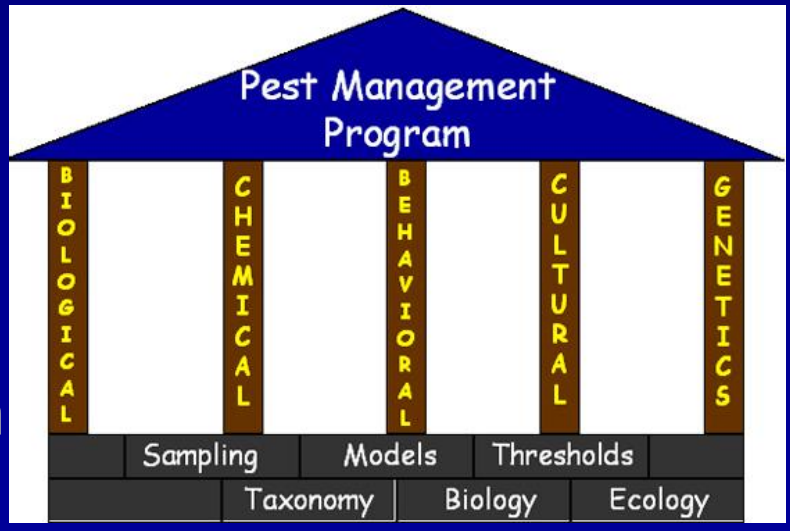
tation and success of host-free periods for managing tomato-infecting whitefly-transmitted geminiviruses (begomoviruses) in developing countries



Robert L. Gilbertson
Department of Plant Pathology
University of California-Davis

l Pest Management (IPM) of Insect-Transmitted Plant Viruses

- An approach that combines multiple management strategies (e.g., biological, chemical, cultural, genetic and physical) selected based on knowledge of the biology of the virus(es)
- Goal is efficient management with minimal inputs of pesticide; economically and environmentally friendly
- Three basic steps:
  1. Correct pathogen ID
  2. Understanding pathogen biology/ disease epidemiology
  3. Development and evaluation of an integrated management strategy



n is identified: Understanding the biology of the virus is necessary for effective disease management

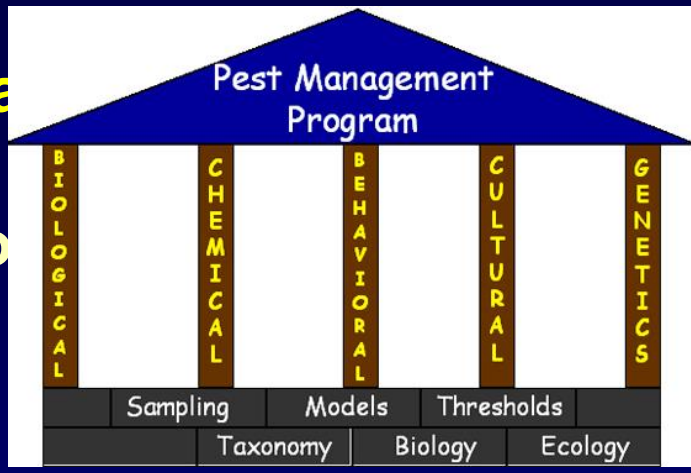
- Biology of the virus
  (host range, mode of transmission, etc.)
- Biology of the insect vector
  (host range, population dynamics etc.)
- Insect-virus interaction
  (mode of transmission)
- Sources of inoculum
  - -seed
  - -weeds/other reservoir hosts
  - -old crops
  - -insects
- Means of survival in the absence of the economic hosts

ase management

anagement strategies ba

on knowledge of the biology of the virus

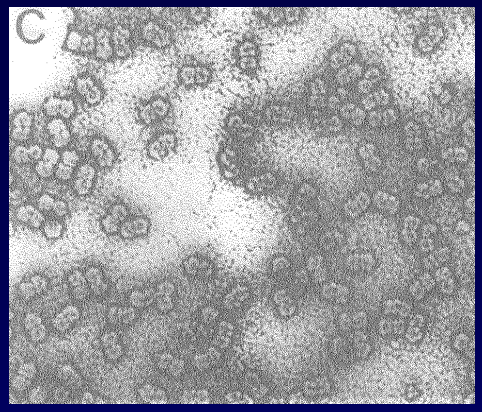
- -regulatory (do not introduce exotic patho on/in seeds and transplants)
- -avoidance (field location, planting dates)
- -disease resistance (conventional and transgenic)
- -pathogen-free propagative materials (seeds and transplants)
- -protection (screenhouses, greenhouses, row covers)
- -disease monitoring and forecasting
- -vector management (insecticides)
- -removal of diseased plants (roguing)
- -sanitation (harvested crops, weeds, volunteers)
- -crop rotation
- -host-free periods



What is a host-free period?

- A means of breaking continuous cropping patterns through a **defined period of time where a susceptible crop(s) are not grown**, resulting in the 'cleansing' of virus inoculum from the agroecosystem
- In temperate regions the winter can provide a natural host-free period
- Best suited to **annual crops harvested over a short period** (e. g., vegetables and cotton)
- **Nature of the host-free period** (e.g., time of year, length, crops involved, area) will depend on crop, cropping system, and virus-host and virus-vector interaction
- Must be done along with **extensive sanitation**
- Can be **legally enforced or voluntary**

Bi hat make a host-free period r management of whitefly-transmitted geminiviruses (WTGs)

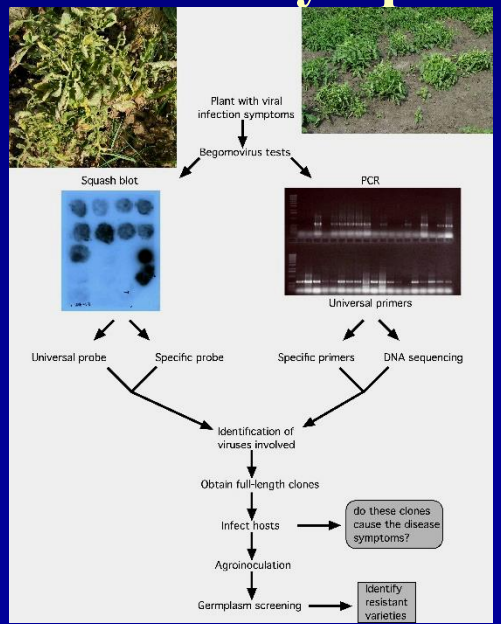


Small ssDNA viruses
WTGs in the genus *Begomovir*

- Not seed-transmitted
- Tend to have narrow host ranges (i.e., most important inoculum source is the crop plant itself)
- Whiteflies have relatively short (~30 day) life cycles and WTGs are not transovarially transmitted
- Many economically important diseases caused by WTGs are in annual crops (cotton, cucurbits, peppers and tomatoes)
- Thus, a 2-3 month host-free period can be a very effective and sustainable management strategy for WTGs and can also reduce whitefly populations

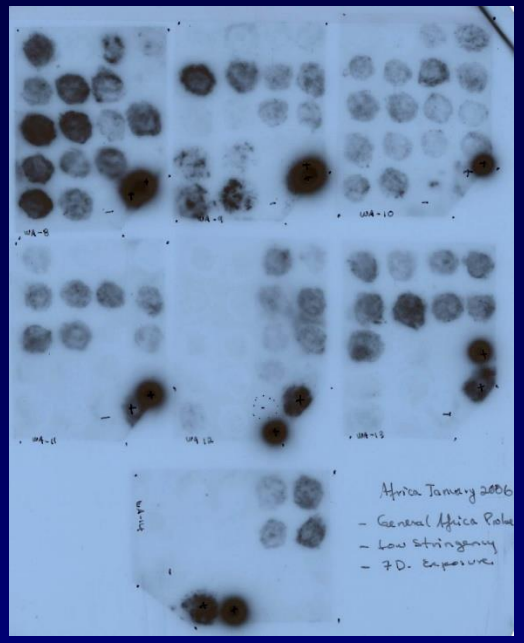
e host-free gement of WTGs in West Africa

- WTGs have emerged as a **major constraint on tomato production** in West Africa
- Molecular characterization has revealed a **complex of at least 5 locally evolved monopartite begomoviruses** and one or more betasatellites causing symptoms of leaf curl, yellow leaf crumple and a severe symptom phenotype

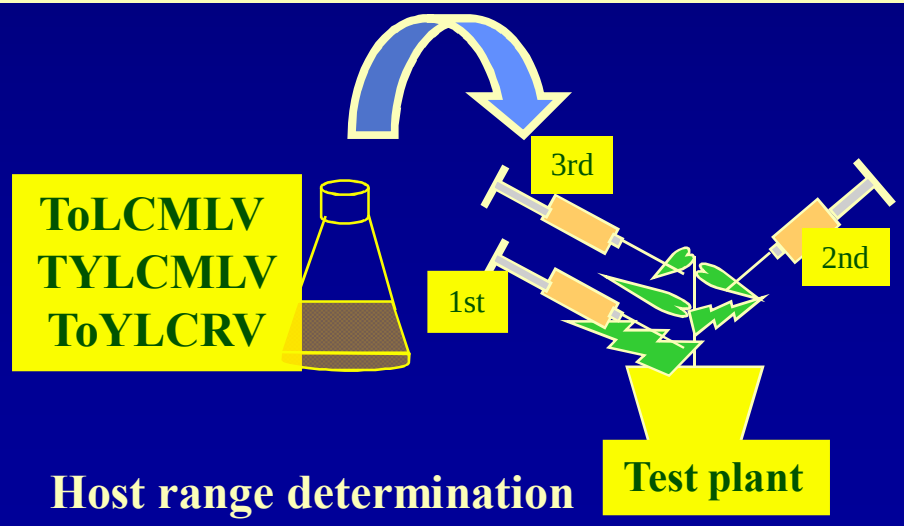


...od be part of an IPM ...plex of WTGs in West Africa?

- **Squash blot (SB) hybridization and SB-PCR tests of crops and potential hosts suggested that the West African tomato WTGs have a narrow host range**
- **Host range studies performed with infectious clones of four of the begomoviruses supported these results and indicated that tomato and tobacco were hosts**
- **Taken together with the other known biological parameters of WTGs, this suggested that a host-free period could be an effective management strategy**



Squash blot hybridization for begomovirus detection

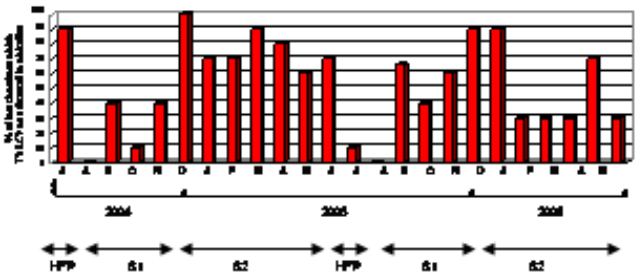


Host range determination by agroinoculation

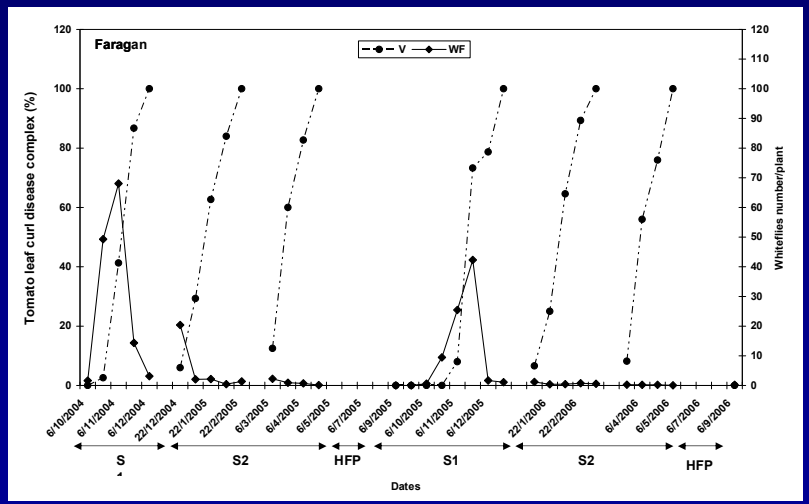
of the host free period in the Bagiuneda ated rice-vegetable perimeter

- The Baguineda irrigated rice-vegetable perimeter was selected as a test site
- This location was so severely impacted by WFGs that tomato production had been abandoned
- The rainy season months (June-August) were selected for implementation of the host-free period
- Meetings were conducted with chiefs of the local villages to explain why the host free period was needed
- The host-free period was implemented along with the planting of early maturing hybrids and a regional sanitation program beginning in 2005

luntary host-free nagement of begomoviruses in West Africa



- Sanitation program initiated: old tomato and pepper plants removed after harvest
- Tomato and pepper free period implemented in June-August
- Seeds of early maturing hybrid tomatoes were distributed to selected farmers
- Monitoring program developed to assess the success of the program
  - -Development of virus symptoms
  - -Detection of virus in whiteflies
  - -Monitoring of whitefly populations



- Saw a reduction in virus levels in whiteflies, delays in development of whitefly populations and virus symptoms and high yields associated with the host-free period

luntary host-free
nagement of begomoviruses in West Africa

- This program has been ongoing for 5 years
- Has allowed for the return of tomato production to Baguineda (in fact bumper crops have created a need for storage technologies)
- The overall importance of WTGs is declining in Baguineda
- Farmers have embraced the program and are seeking to purchase seed of the early maturing hybrids
- An NGO has scaled-up the program to access more farmers in Baguineda and other locations
- Host-free periods are being expanded to new areas in Mali

eriod can be an effective tool for anagement of WTGs

- Based upon knowledge of the biology of the virus
- Should be part of an IPM program (e.g., combined with an effective sanitation program)
- Sustainable and inexpensive
- Must be a regional effort
- Can be voluntary or enforced
- Could be used anywhere where WTGs are a constraint on tomato production