Meeting the Challenge of the Asian Citrus Psyllid in California Nurseries
A two-day workshop in Riverside, California
June 11-12, 2009

Invited Speakers:
J. Ayres - Fundecitrus, Brazil
J. Bethke - UC, CA
G. Baze - Golden Pacific Structures, CA
T. Delfino - CCNS, CA
F. Dixon - Wells Fargo, CA
D. Elder - American Ag Credit, CA
T. Gast - Southern Gardens Citrus, FL
P. Gomes - CHRP, USDA-APHIS, NC
E. Grafton-Cardwell - UCR, CA
D. Howard - AgraTech, CA
N. Jameson - Brite Leaf Nursery, FL
R. Keijzer - KUBO, The Netherlands
P. Llatser - AVASA, Spain
S. McCarthy - CDFA, CA
G. Vidalakis - UCR-CCPP, CA

Organizing Committee:
T. Delfino - California Citrus Nursery Society
A. Eskalen - Dept. of Plant Pathology & Microbiology, University of California Riverside
R. Lee - USDA-ARS, National Clonal Germplasm Repository for Citrus and Dates
G. Vidalakis - Citrus Clonal Protection Program, Dept. of Plant Pathology & Microbiology, University of California Riverside

Registration:  http://ccpp.ucr.edu & http://eskalenlab.ucr.edu

Location:
Sunkist Center
Citrus State Historical Park
9400 Dufferin Avenue
(Corner of Van Buren Blvd)
Riverside, California

Information on line at:  http://eskalenlab.ucr.edu

Sponsored by:
California Citrus Nursery Board
Stuewe & Sons, Inc.
Golden Pacific Structures
Agratech
Bayer CropScience
“The Sao Paulo State Citrus Nursey Experience”

Antonio Juliano Ayres
Fundecitrus
Brazil - Orange production area

2050 thousand acres

Pará – 1.4%

Bahia / Sergipe - 12%

S.Paulo / Minas – 76%

Source: IBGE
Citriculture in São Paulo State

- 350 millions of orange boxes (2008)
- 1.65 million of acres (orange 95%)
- Average productivity: 22 ton/ha
- 85% groves without irrigation
- 50 % of the orange juice market
- 400,000 direct jobs
- Challenge: HLB
Important diseases - The Begining

TRISTEZA

GUMMOSIS
Main Challenges - Today

- Citrus Sudden Death
- Citrus Canker
- Leprosis
- Citrus Black Spot
- Greening

CVC
Citrus Leprosis Virus

- Important problem in the 70's and 80's;
- Transmission by mite (*Brevipalpus phoenis*);

**Strategies of Control:**
- Monitoring the mite;
- Spray with miticide;
- Prunning of symptomatic branches.
Black Spot

- Causal agent: *Guinardia citricarpa* (fungi);
- Detection in São Paulo in 1992;
- Importance: fruit drop.

**Management:**

- Spray with fungicide (2 – 4 times/year);
- Health citrus material (screenhouse nurseries).
Citrus Canker

- Causal agent: *Xanthomonas axonopodis* pv. *citri*;
- Erradication Program since 1957;
- After introduction of citrus leaf miner in 1996 there was a change in the epidemiology of the disease;

**Strategies of Control:**

- Change in the law: more inspections and stronger erradication procedures;
- Fundecitrus: 1500-4000 inspectors;
- Screenhouse nurseries.
Citrus Canker

Law

< or = 0,5 %

> 0,5 %
## Citrus Sudden Death (CSD)

- **Detection in 2001**: new disease (similar to quick decline);
- **Susceptible rootstock**: Rangpur, Volkameriano and rough lemon;
- **Causal agent**: virus;
- **Vector**: probably aphids;
- **Disease is restricted to the North of São Paulo and South of Minas Gerais State.**
Inarching effect

Block with inarching

Block without Inarching
Citrus Variegated Chlorosis (CVC)

- Causal Agent: *Xylella fastidiosa*;
- Transmission: sharpshooter and contaminated buds;
- Importance: new disease, productivity reduction, etc.
- CVC intensity in 2005: 43%

Solution - Development of management practices:

- Health nurseries trees (screenhouse nurseries);
- Vector control;
- Pruning/removal of symptomatic trees.
CVC – Symptoms and Damages

Xylella fastidiosa

70% weight reduction
1. Inspection and elimination of symptomatic trees

2. Chemical control of sharpshooters

3. Healthy young plant

CVC Control
Huanglongbing - Destructive disease

Bacteria in the phloem

Transmitted by insect and grafting
Huanglongbing (HLB): Main Challenge

- Presence of *Diaphorina citri* since 1942;
- Detection of HLB: March, 2004;
- Bacteria:
  - *Candidatus Liberibacter asiaticus*
  - *Candidatus Liberibacter americanus*
HLB Affected Municipalities in São Paulo State

March, 2004

Source: Fundecitrus
1. Inspection and elimination of symptomatic trees

2. Chemical control of psyllids

3. Healthy young plant

HLB Control
Citrus Nursery Program in São Paulo State

- Voluntary Field Nursery Program

- Mandatory Screenhouse Nursery Program
### Field Nursery Program (until 1998):

- About 1000 nurseries (10 to 20 million trees/year);
- Most of the field nurseries were closed to the groves;
- Risk of contamination of diseases as *Phytophthora*, nematode, citrus canker and CVC.

**Important:**

The risk of CVC in the nurseries was the main point to have a “mandatory screenhouse nursery program” !!!
Citrus Nurseries in São Paulo, Brazil

**LOCATION**

Close to citrus orchards (81%)

Far from citrus orchards (19%)
Phytophthora Risk in Field Nursery

A) *Phytophthora (Gomosis)*:

High incidence in the nurseries. WHY?

- Small distance from groves;
- Contamination of soil, water and seedlings;
- Intensity of Rain (1200 – 1500 mm/year);
- Production of nursery in the same area;
- Susceptible rootstock: Rangpur, Cleopatra and Sunki;
- Overhead irrigation

Important:

Same risk in relation to nematodes!!!
Phytophthora Symptoms
Citrus Canker Risk in Field Nursery

Some cases of canker in the nurseries ("Nursery eradication by law").

WHY?

- Small distance of groves (risk of disease spread by wind and personnel);
- Presence of citrus leaf miner in the nurseries;
- Environment condition (intensity of rain, overhead irrigation etc).
C) Citrus Variegated Chlorosis (CVC):

- A lot of groves affected by CVC were close to nurseries;
- It was almost impossible to control sharpshooters in the nurseries;
- High risk to contaminate nurseries trees.
Presence of the Sharpshooters that are vectors of CVC in the field nurseries
Citrus Nursery Tree Certification Program in the State of São Paulo

Voluntary Program

Mandatory Program

**Deadlines**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Deadline for Fullfillment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production of seedlings in screenhouse</td>
<td>July, 2000</td>
</tr>
<tr>
<td>Production of nursery trees in screenhouse</td>
<td>January, 2001</td>
</tr>
<tr>
<td>Commercialization restricted only to nursery trees produced in screenhouse</td>
<td>January, 2003</td>
</tr>
</tbody>
</table>
Detection of *Phytophthora* in Screenhouse Nurseries

Contaminated Samples

<table>
<thead>
<tr>
<th>Year</th>
<th>% Contaminated Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>25.9</td>
</tr>
<tr>
<td>2001</td>
<td>14.7</td>
</tr>
<tr>
<td>2002</td>
<td>9.0</td>
</tr>
<tr>
<td>2003</td>
<td>4.9</td>
</tr>
</tbody>
</table>
Citrus Nurseries in São Paulo

NEMATODE SURVEY
April to May, 2000

Field nurseries

61.4% 38.6%

1,334 samples from 300 nurseries

Screenhouses

0.9%

586 samples from 94 nurseries

Nematode contaminated samples
Samples free of nematodes

Source: UNESP/Jaboticabal

Fundecitrus
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1- Legislation</td>
<td></td>
</tr>
<tr>
<td>2- Number of nurseries</td>
<td></td>
</tr>
<tr>
<td>3- Varieties X Rootstocks</td>
<td></td>
</tr>
<tr>
<td>4- Quality of Nurseries Trees</td>
<td></td>
</tr>
<tr>
<td>5- Time to produce a nursery tree</td>
<td></td>
</tr>
<tr>
<td>6- Nursery structure</td>
<td></td>
</tr>
<tr>
<td>7- Operation system</td>
<td></td>
</tr>
<tr>
<td>8- Main results of this program.</td>
<td></td>
</tr>
</tbody>
</table>
1- Legislation

GOAL:

Produce a good nursery tree

(Genetics, Health and Vigour)
Citrus budwood registration program in São Paulo

- Imports
- Quarantine
- Breeding Programs
- Local Selections
- Candidate Tree
  - Indexing
  - Thermotherapy
  - Shoot-tip grafting
- Foundation Block
- Rootstock Foundation Block
  - Indexing
  - Cross-Protection (CTV)
  - Horticultural evaluation
- Foundation block (screenhouse)
- Multiplication block (screenhouse)
- Nursery tree production (screenhouse)
## Nursery: Mandatory Program

<table>
<thead>
<tr>
<th>Year</th>
<th>Field</th>
<th>Screen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>948</td>
<td>24</td>
<td>972</td>
</tr>
<tr>
<td>2009</td>
<td>00</td>
<td>543</td>
<td>543</td>
</tr>
</tbody>
</table>

Nursery Trees: 18 million  
Rootstocks: 8 million  
(April, 2009)
## 3- Varieties X Rootstocks

<table>
<thead>
<tr>
<th>Varieties</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>PERA</td>
<td>33,36</td>
</tr>
<tr>
<td>VALENCIA</td>
<td>26,61</td>
</tr>
<tr>
<td>HAMLIN</td>
<td>11,78</td>
</tr>
<tr>
<td>NATAL</td>
<td>5,89</td>
</tr>
<tr>
<td>“FOLHA MURCHA” VALENCIA</td>
<td>4,60</td>
</tr>
<tr>
<td>OTHERS</td>
<td>17,76</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rootstocks</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>RANGPUR LIME</td>
<td>58,28</td>
</tr>
<tr>
<td>SWINGLE CITRUMELLO</td>
<td>20,39</td>
</tr>
<tr>
<td>SUNKI MANDARIN</td>
<td>11,29</td>
</tr>
<tr>
<td>VOLKAMERIANO LEMON</td>
<td>3,83</td>
</tr>
<tr>
<td>CLEOPATRA MANDARIN</td>
<td>3,42</td>
</tr>
<tr>
<td>OTHERS</td>
<td>2,79</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Fundecitrus (April, 2009)
4- Nursery Tree Quality

Genetics

Vigour

Health
Genetics

- Combination of variety and rootstock (productivity, fruit quality, etc.)

- It’s essential to have a “system” that control the production of citrus buds and seeds of rootstock.
Function of:

- Rootstock selection;
- Screenhouse condition: light, temperature etc;
- Management practices: irrigation, nutrition and quality of “substrate”;
- Size of plastic bag or container and space between nursery trees.
5- TIME TO PRODUCE A NURSERY TREE

<table>
<thead>
<tr>
<th>Phases</th>
<th>Time in Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seedling</td>
<td>3 – 4</td>
</tr>
<tr>
<td>From transplanting seedlings to graft</td>
<td>3 – 4</td>
</tr>
<tr>
<td>From graft to nursery tree</td>
<td>4 – 6</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>10 – 14 months</strong></td>
</tr>
</tbody>
</table>
6- Nursery Structure

- Isolation and wind-break
- Disinfestation System
- Bath, Dressing room and laundry
- Seed and Budwood Storage
- Seedling and Nursery Screenhouse
- Nursery Tree Screenhouse Storage
Isolation and wind-break
Nursery Office
Vehicle Disinfestation
Personnel Disinfestation
Laundry
Internal Seedling Screenhouse
Internal Screenhouse with Aluminet curtains
Internal Screenhouse
Nursery Tree Storage
### 7- Operation System

<table>
<thead>
<tr>
<th>- Seed and Seedling Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Substrate Operation</td>
</tr>
<tr>
<td>- Bud Production and Graft Procedures</td>
</tr>
<tr>
<td>- Bench and Floor</td>
</tr>
<tr>
<td>- Tree Spacing</td>
</tr>
<tr>
<td>- Fertirrigation</td>
</tr>
<tr>
<td>- Chemical Control</td>
</tr>
<tr>
<td>- Human Resources</td>
</tr>
</tbody>
</table>
Seed Manipulation
Screenhouse Seedling
Substrate Operation
Bench and Floor

PERMISSION REQUIRED FOR USE
Budwood production-
Increase block
Annual disease testing and pest inspections
Graft Operation
Grafted plants
Fertirrigation
Insecticide in the Nursery

PERMISSION REQUIRED FOR USE
Main Results of the Mandatory Screenhouse Nursery Program

a) Nematode Absence in the nurseries
b) Strong Reduction of *Phytophthora* and Citrus Canker in the nurseries
c) Bad environment condition to Black Spot in the nurseries
d) Absence of CVC and HLB in the nurseries!
“Nursery young trees with high quality are the basis of the competitive citriculture”
Thank you!