Huanglongbing in the State of São Paulo – Brazil
Current situation, regulation, management and economic impact

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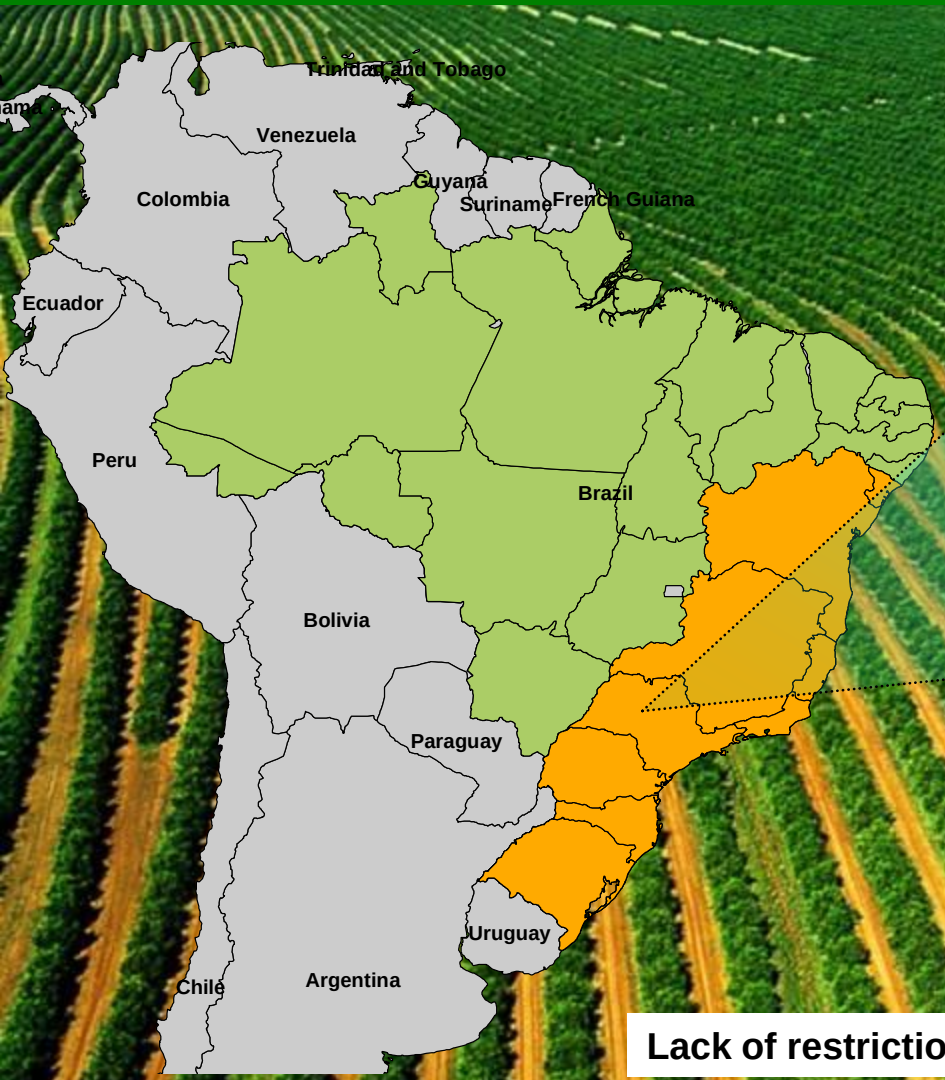
Presentation topics

- Introduction
- HLB progress and current situation
- HLB management and regulations
- Factors associated to disease control success
- HLB economic impact
- Conclusion

Citriculture in Brazil and in the State of São Paulo



80% of country production
333 municipalities
400,000 jobs

More than 600,000 Ha
200 million trees
92% sweet orange
. 4 varieties
. 1 rootstock
15 – 20 year life span

Lack of restriction barriers

Continuity in space, susceptible tissues and time

Disease introductions

Epidemics

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Main citrus diseases

Huanglongbing (HLB) or greening

***Candidatus* Liberibacter americanus**

***Candidatus* Liberibacter asiaticus**

Pigeon pea witches-broom phytoplasma

***Ca.* L. asiaticus**
Capoor et al 1967 (India)
Martinez & Wallace 1967 (Philipines)

***Ca.* L. americanus**
Yamamoto et al 2006 (Brazil)

HLB affects all commercial citrus varieties and species





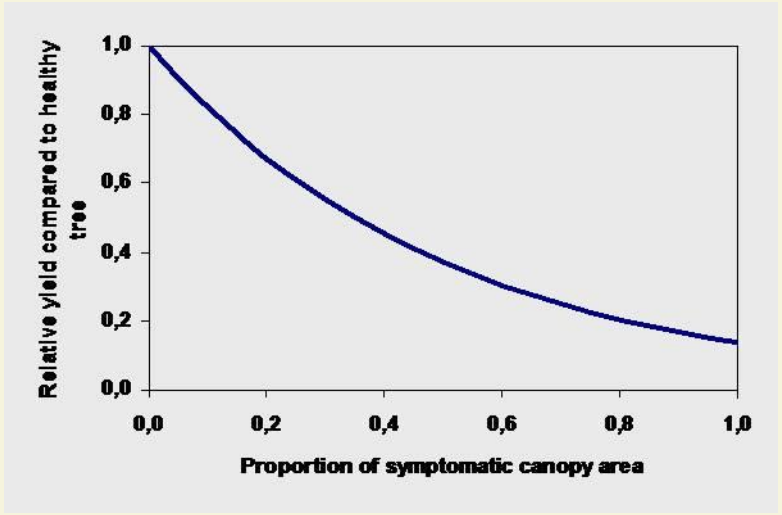

In which the symptom progresses very fast

The Liberibacters also affect the ornamental *Murraya paniculata*

Symptom progress on a *Murraya paniculata* affected by *Ca.* L. americanus

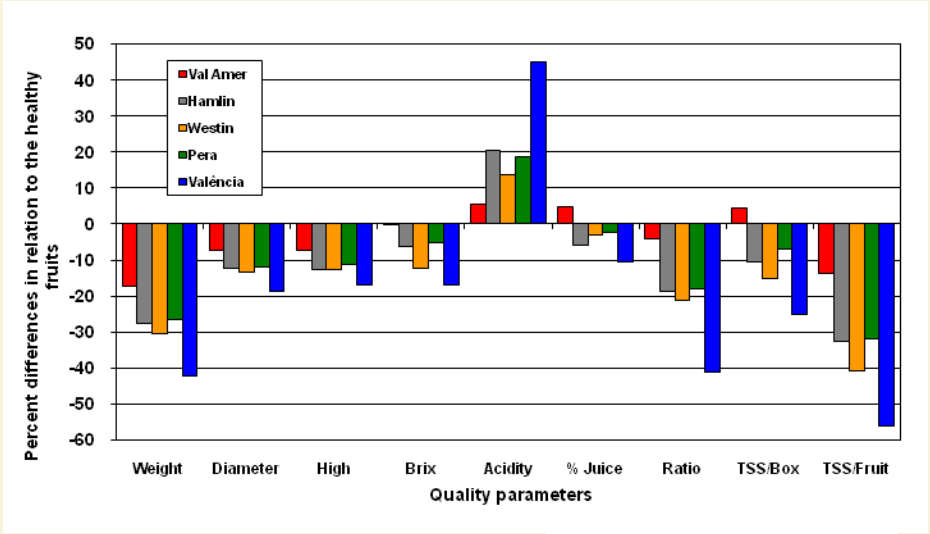
Severe decrease in fruit number and quality

HLB + HLB -



X

HLB + HLB -



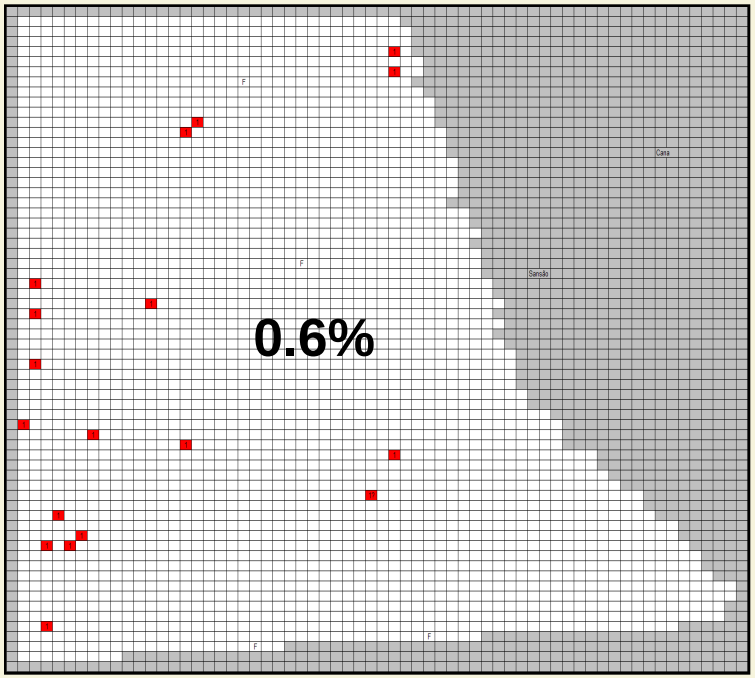
Bassanezi et al 2006

Increase of HLB incidence in young orchards

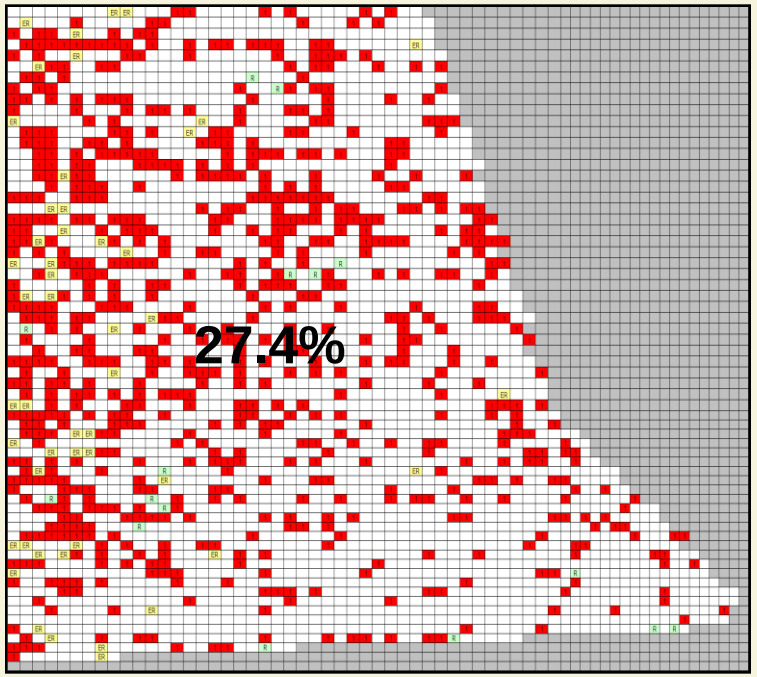
2-y-old Hamlin/Rangpur lime

Affected adult trees

Affected adult trees



August 2004



9 months later

Bassanezi et al 2007

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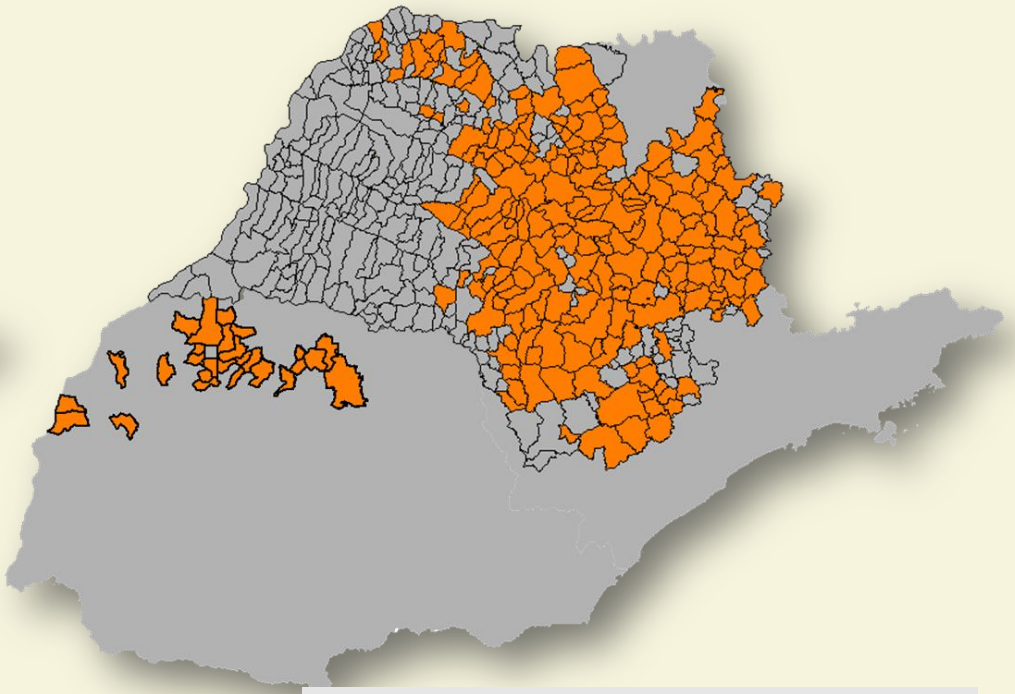
HLB spread in São Paulo and Paraná States

2004

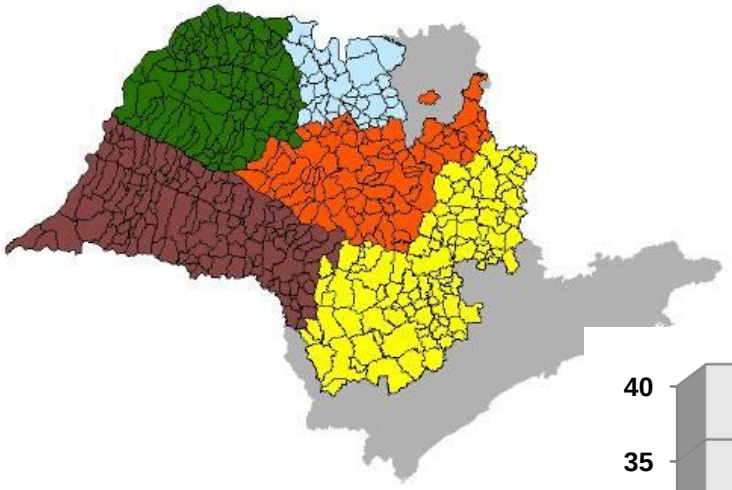
2009

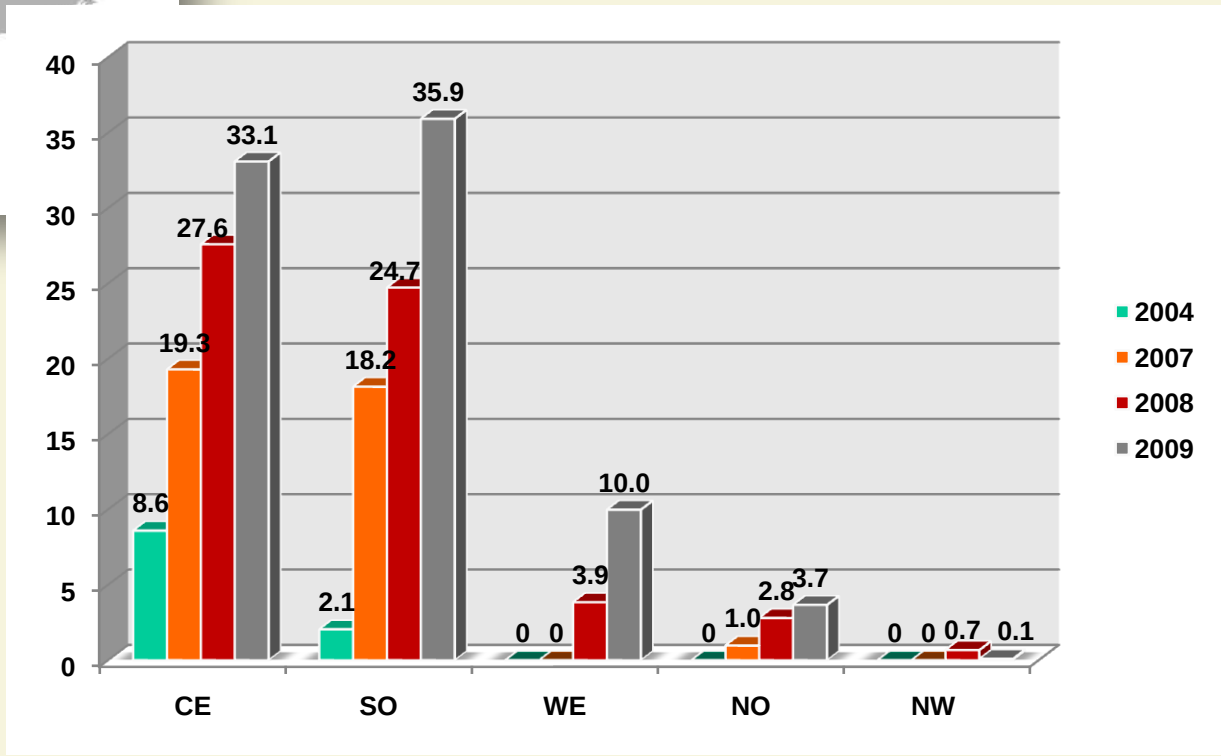


Affected municipalities (May 2009)

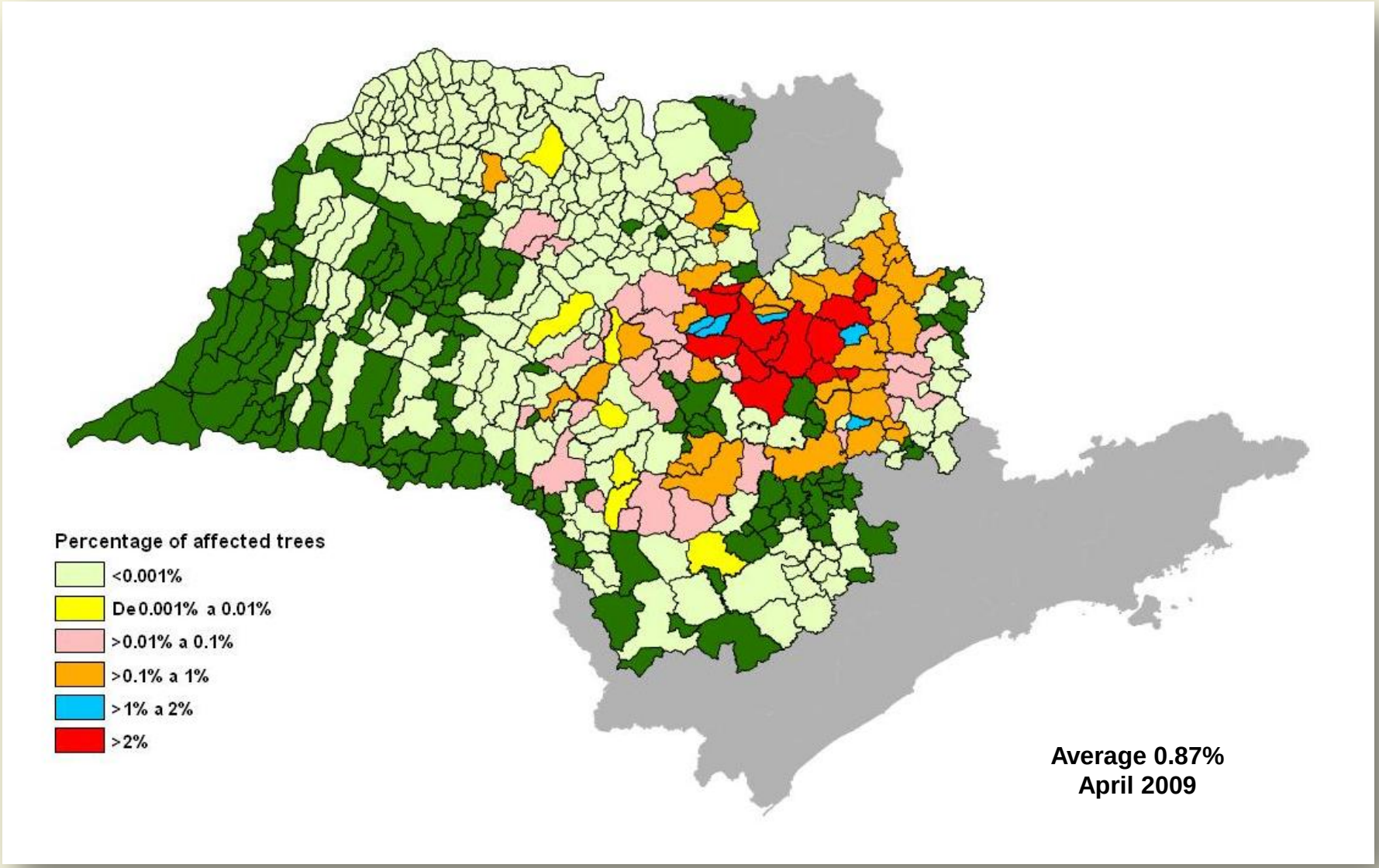
- **216 in São Paulo (SP)**
- **1 in Minas Gerais (MG)**
- **34 in Paraná (PR)**

In SP, HLB progressed faster in the center and south of the State





Current situation



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Disease management

Elimination of symptomatic trees

Insecticide applications

Planting healthy young trees

Regulation of symptomatic tree elimination

Federal normative instructions

IN10 (March 2005)

- Elimination of all symptomatic citrus trees
- Elimination of *M. paniculata*
- Tree identification and elimination were made by official and Fudencitrus inspectors
- Required laboratory analysis of each suspected tree
- At least 2 inspections per year

IN32 (September 2006)

- Transferred to the grower all the responsibility for detection and removal of symptomatic trees
- Two inspections per year reported to the government
- These processes overseen by officials inspectors

IN53 (October 2008)

- Created a threshold of 28% above which all trees in the block must be eliminated
- 4 inspections per year reported to the government
- Compound samples per block

Regulation of symptomatic tree elimination

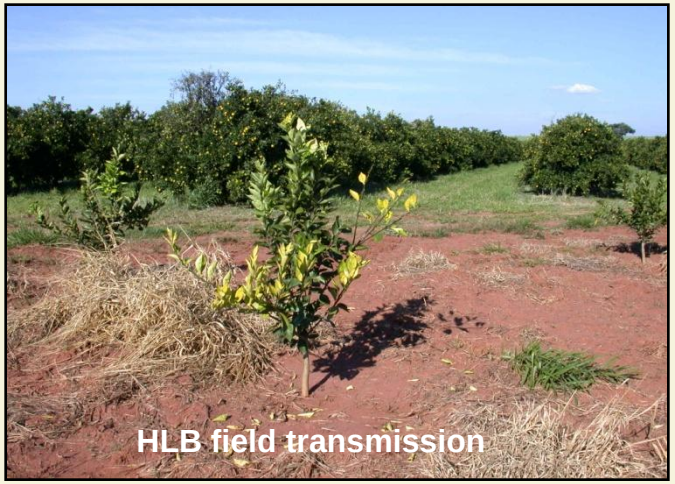
Total 216 pruned trees
Disease reappeared in 58.3%

Total 376 pruned trees
Disease reappeared in 62.5%

Sweet orange variety, age and symptom severity

Lopes et al 2007

Regulation of nursery tree production



	Field	Screen	Total
1998	948	24	972
2009	00	520	520

April, 2009
18 million nursery trees and 8 million rootstocks were under screen

Regulation of nursery tree production

Liberibacter transmission through budwood grafting

	Ca. L. americanus	*Ca.* L. asiaticus
		
From symptomatic branches	0.9 and 2.1%	100%
From asymptomatic branches of affected trees	0 and 0	11.1%
From asymptomatic trees of very affected orchards	0 and 0	0
	Lopes and Frare 2008	Unpublished results

Ways used to find the symptomatic trees

48% efficiency

60% efficiency

Belasque 2006

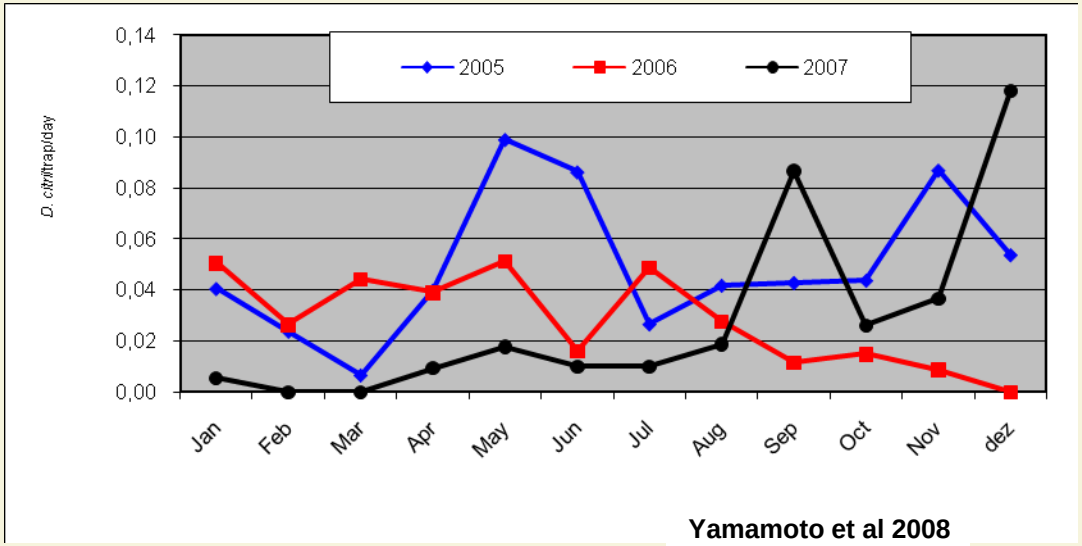
Ways to find the symptomatic trees

What the inspectors look for

Symptomatic trees are tagged

And immediately eliminated

Vector control requires constant insecticide applications



Yamamoto et al 2008

Available efficient insecticides (to kill the vector)

Systemic

Imidacloprid (SL)

acetamiprid (SL)

→ Trunk

Aldicarb (G)

Thiamethoxam (G)

→ Soil

Imidacloprid (WG)

thiamethoxam (WG)

→ Drench

Contact

Neonicotinoid: thiamethoxam, imidachloprid, acetamiprid

Organophosphate: cefanol, dimethoate, ethion, malatol, chlorpiriphos, methidathion

Pyretroids: deltamethrin, lambda-cyhalothrin, fenpropathrin

Carbamate: carbosulfan

Others: abamectin, etofenprox

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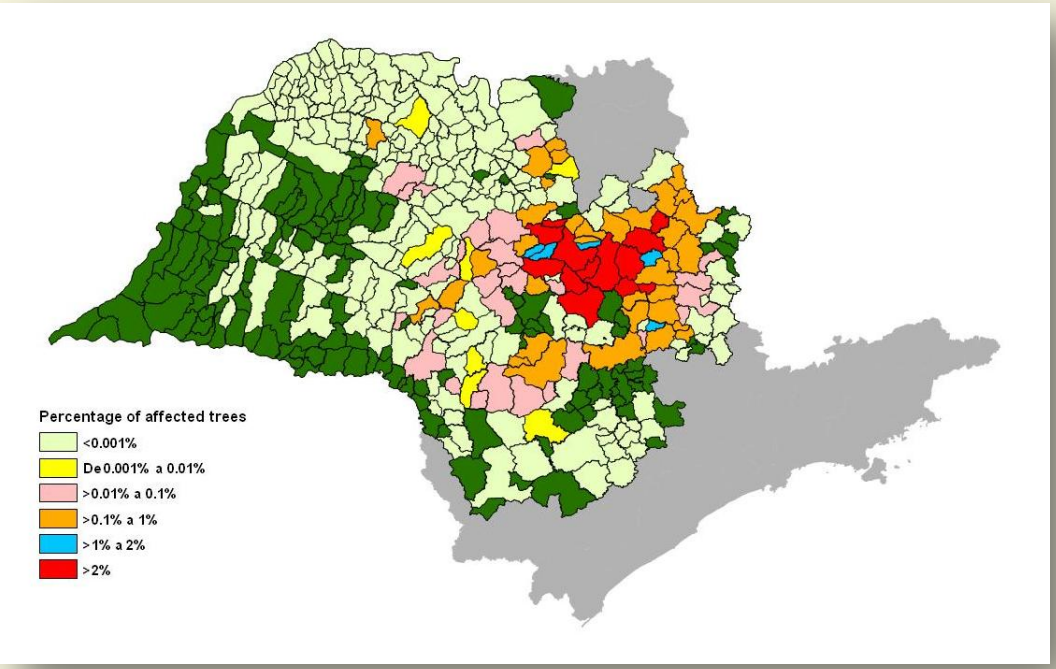
Despite all these efforts, HLB incidence has dramatically increased in some farms

A study of cases



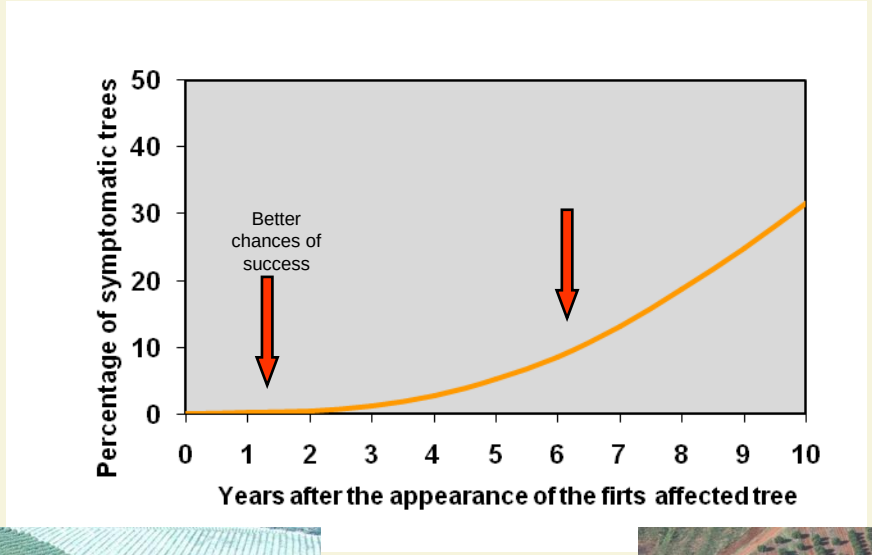
Study of cases carried out in SP in 2008

Data from 20 farms from distinct locations

were submitted to multiple regression analysis

Most important factors for all farms

1. HLB incidence in the first year of control



Most important factors for all farms

2. Average age of the trees

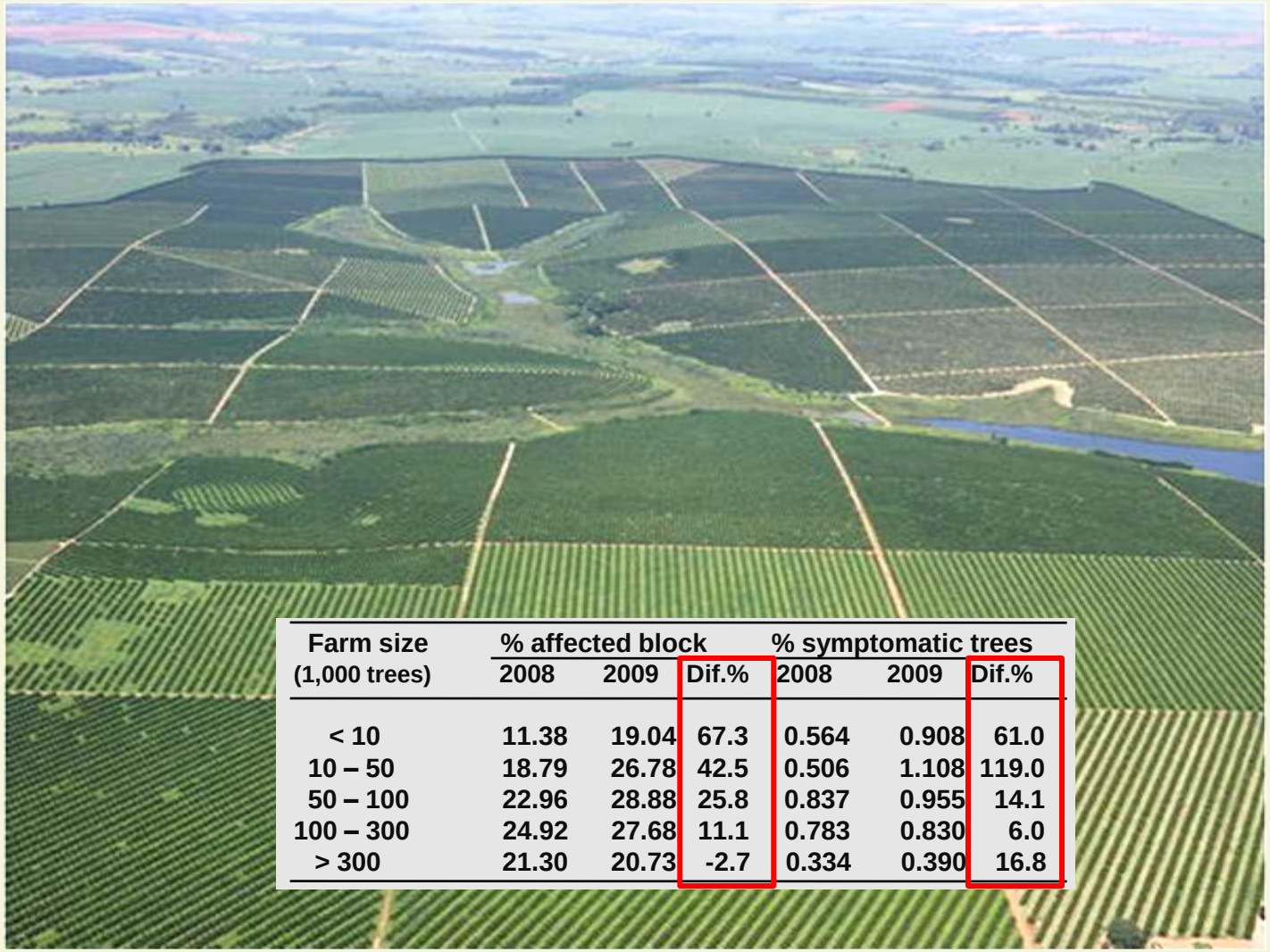
Trees from 4 to 20 years of age

3. Time period the control measures have been adopted

Periods of 14 to 50 months

Most important factors for all farms

4. Size of the farm (total number of trees)



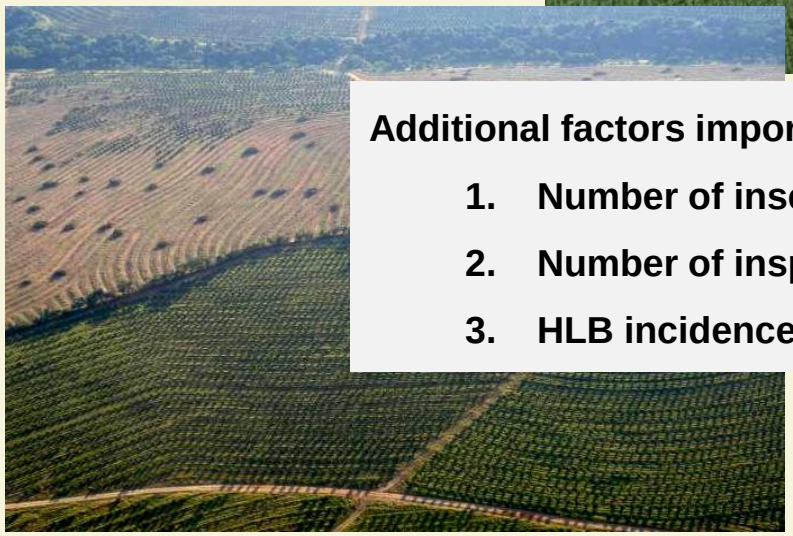
Farm size (1,000 trees)	% affected block 2008	2009	Dif.%	% symptomatic trees 2008	2009	Dif.%
< 10	11.38	19.04	67.3	0.564	0.908	61.0
10 – 50	18.79	26.78	42.5	0.506	1.108	119.0
50 – 100	22.96	28.88	25.8	0.837	0.955	14.1
100 – 300	24.92	27.68	11.1	0.783	0.830	6.0
> 300	21.30	20.73	-2.7	0.334	0.390	16.8

240 to 10,000 hectares
72,000 to 3,000,000 trees

Most important factors for all farms

5. Distance from farms not practicing HLB control

Distance in between farms 0 to 5 km



Additional factors important for some farms

1. **Number of insecticide sprays per year**
2. **Number of inspections per year**
3. **HLB incidence in the municipality the farm is located**

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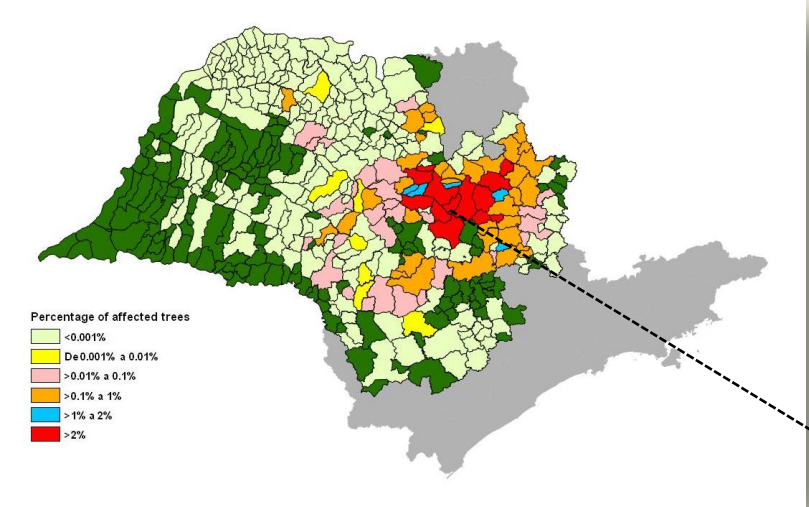
HLB economic impact



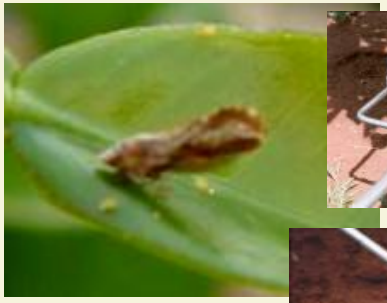
Year	Million boxes of 40.8 Kg
2003	327
2004	360
2005	352
2006	352
2007	360
2008	360

98% of the entire citriculture have not been affected by HLB

Losses caused by citrus diseases in SP (Million US$/year)

Disease	Tree removal	Yield reduction
Citrus canker	5.1 (0.13%)	----
CVC	120.0 (3.00%)	121.8
HLB	34.4 (0.86%)	?
Citrus Blight	160.0 (4.00%)	?
Citrus Sudden Death	6.0 (0.15%)	?
Leprosis	0	?
Citrus Black Spot	0	?
PBFD	0	?
TOTAL	325.5	>121.8 >447.3

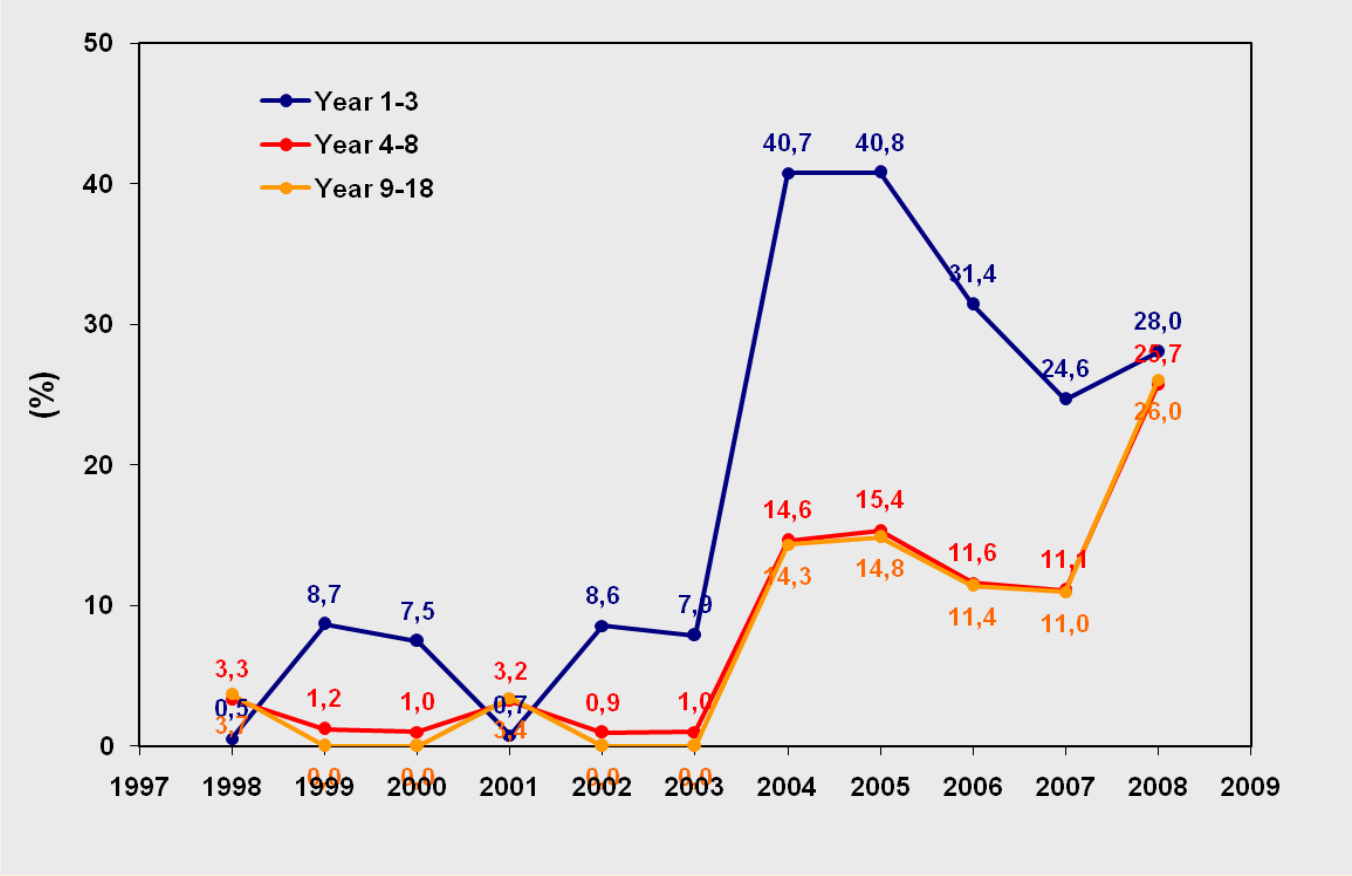
HLB economic impact



Preventive costs of control of citrus diseases in SP (Million US$ / year)		
Disease	**Million dollars**	**Control practices**
CVC + HLB	**173.3**	**Insecticide application (~6x) + inspection (~6x - 40%)**
Leprosis	**123.5**	**Mitecide application (~2x – 100%)**
Black spot	**69.9**	**Fungicide application (~4x – 47%)**
Citrus canker	**36.0**	**Inspection and eradication (Fundecitrus+growers)**
PBFD	**27.5**	**Fungicide application (~2x – 56%)**
TOTAL	**430.2**	

HLB economic impact

Weight of <u>insecticide costs on phytossanitary cost</u> of non bearing (year 1-3), increasing yield bearing (year 4-8) and stable yield bearing (year 9-18) sweet orange groves



<u>Phytossanitary costs</u>: mechanical spray operation, manual spray operation, pruning, pest and disease scouting, mitecide, insecticide, fungicides, and mineral oil.

Region of Araraquara-SP;Spacing 7.0 x 3.5 m; 408 trees/ha

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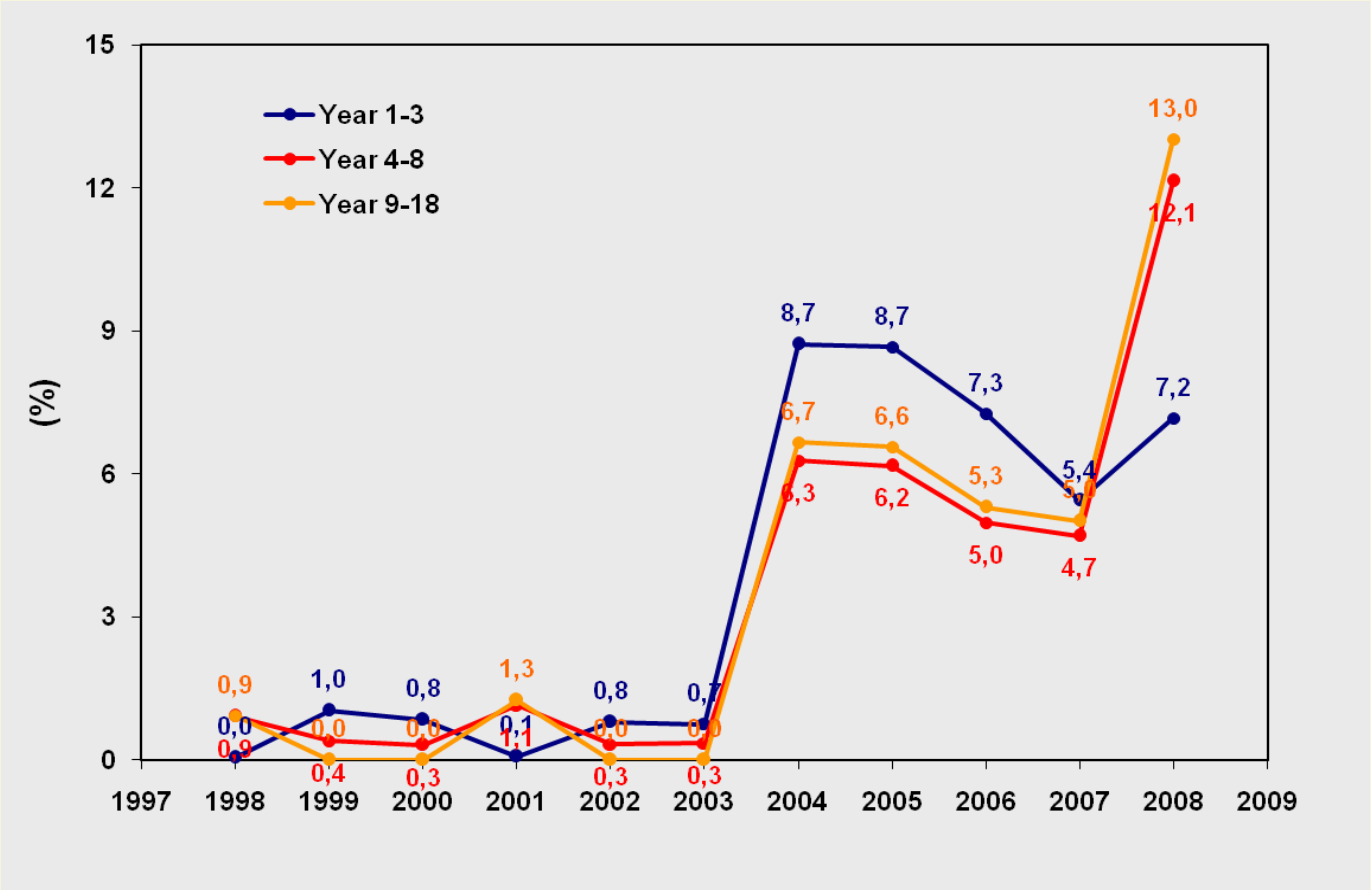
Source: Agrianual 1999 to 2009 (iFNP) , compiled by R. B. Bassanezi

HLB economic impact

Participation of insecticide costs on total production cost of non bearing (year 1-3), increasing yield bearing (year 4-8) and stable yield bearing (year 9-18) sweet orange groves



Region of Araraquara-SP
Spacing 7.0 x 3.5 m
408 trees/ha

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Conclusion

1. The future of the São Paulo citriculture is endangered in the presence of HLB

2. HLB spread very fast to new areas and reached very high incidences in several farms located in the center of SP responsible for 30-40% of the entire State production

3. The situation requires urgent law enforcement and scientific actions

4. The effective HLB control is beyond the power of many small growers

5. A wide and strong campaign to call the grower attention to the HLB is also needed

6. The current management control package is economically and environmentally unsustainable in a long term

Conclusion

7. **The scientific community should look for answers to key questions like:**

   a. **Can insecticide prevent new infections ?**

   b. **How effective insecticide applications are comparing with symptomatic tree elimination ?**

   c. **What is the role of infected but asymptomatic citrus trees as source of inoculum ?**

   d. **What is the role of infected *Murraya* trees as source of inoculum to citrus orchards**

   e. **How to improve field diagnosis ?**

Muchas Gracias