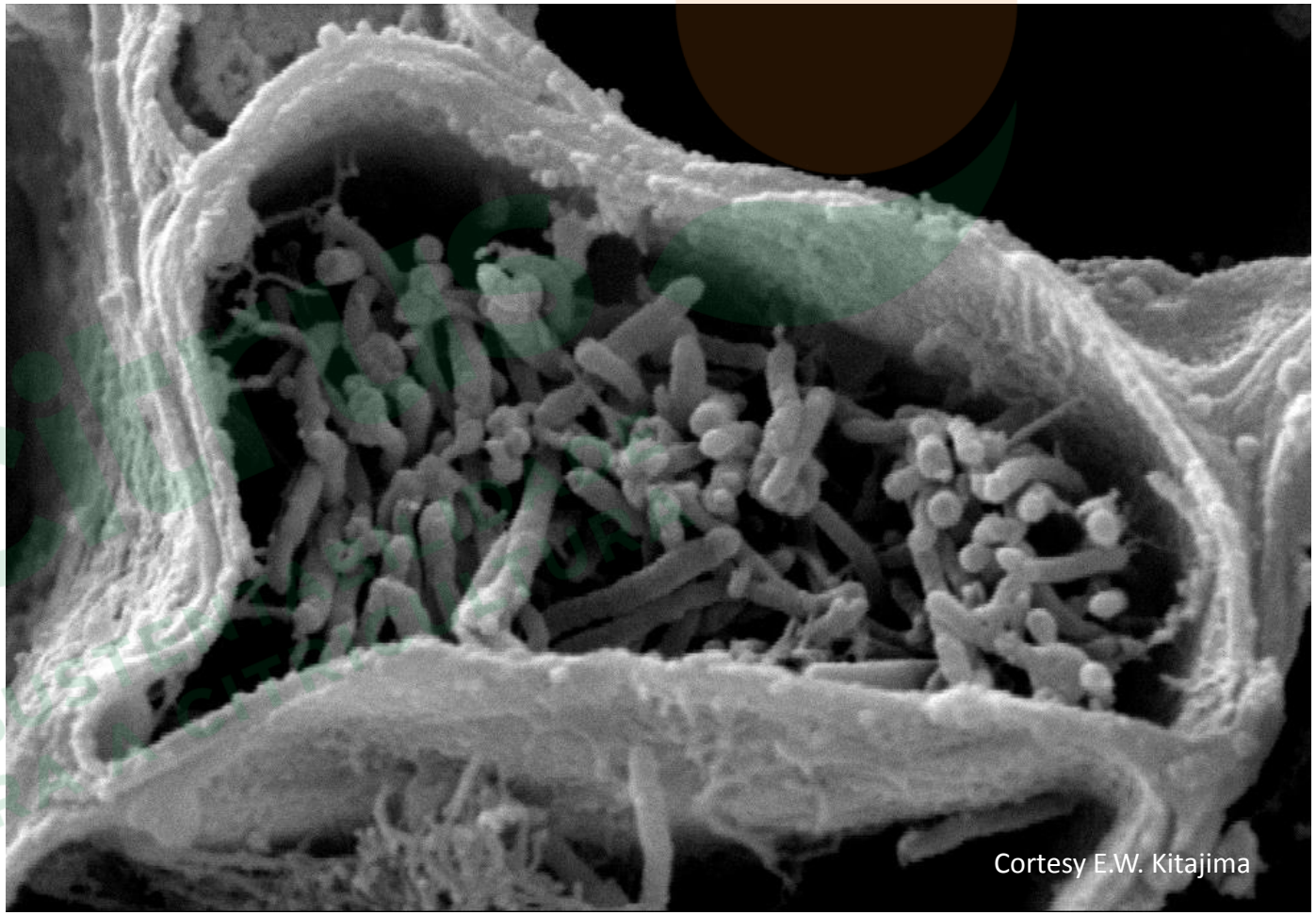
HLB management

Renato Beozzo Bassanezi
renato.bassanezi@fundecitrus.com.br

Huanglongbing (HLB, greening)

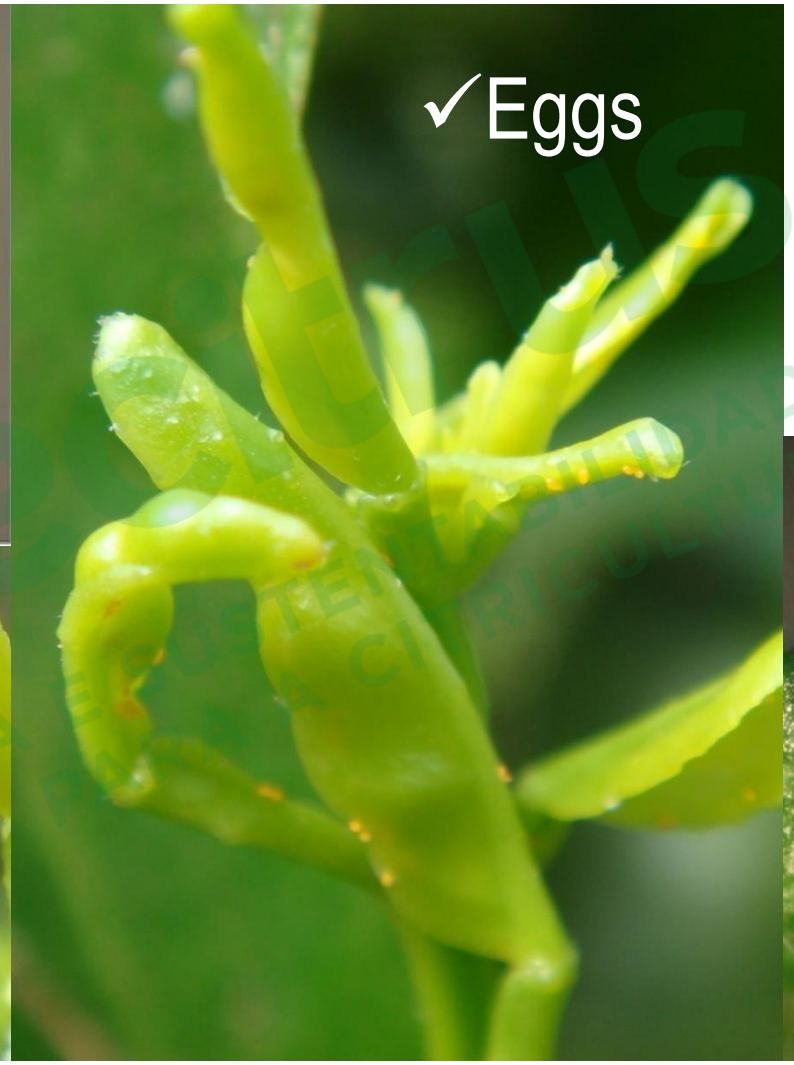
Candidatus Liberibacter asiaticus

- Restrict to the sieve tubes
- Transmission
  - Not by seeds
  - Tissue-grafting
  - Vector (*Diaphorina citri*)



HLB Vector

Asian citrus psyllid *Diaphorina citri* (Hemiptera: Liviidae)



- Life cycle (14 to 47 days)
- Feeding, oviposition and nymph development on new shoots

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HLB Symptoms

- Affect all *Citrus* (oranges, lemons, acid limes, mandarins) and some relatives

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HLB Symptoms

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HLB Symptoms

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HLB Premature fruit drop

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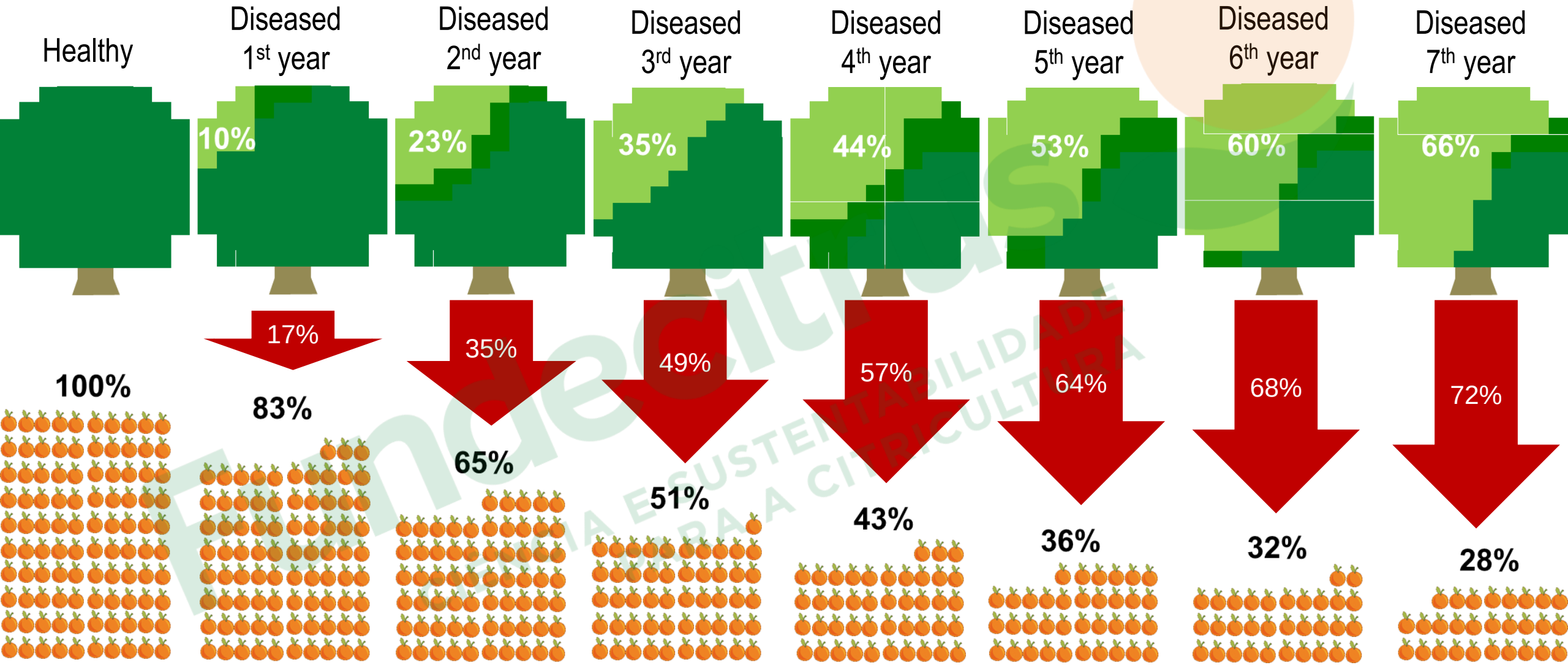
HLB Progress of disease severity and yield loss



Bassanezi 2018

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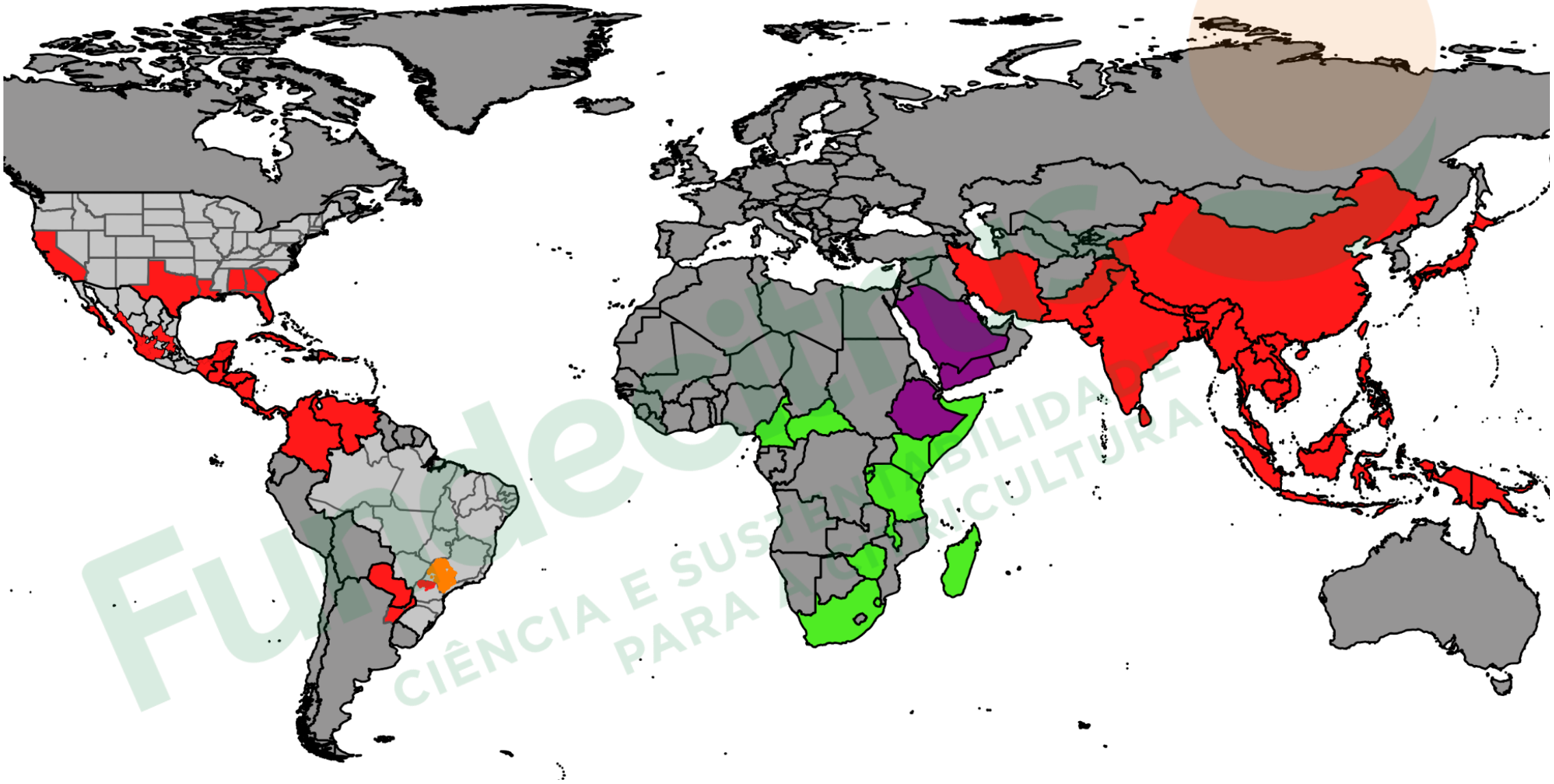
HLB Fruit and juice quality reduction

	Orange	Lemon	Tahiti
Fruit aspect	↓↓	↓↓	↓
Weight and size	↓↓↓	↓↓	↓
Juice content (%)	↓	↑	↑
Brix	↓	↓	↓
Acidity	↑	↓	↓
Limonin	↑↑	↑	↑
Flavonoids	↑↑↑	↑	↑↑
Essential oils	↓	↑	↓

Bassanezi et al 2017, Cifuentes-Arenas et al 2018

HLB a threat to the world citrus industry




Live with the disease
and seek a cure
Manage to prevent
infections

Attempts to cure and remission of symptoms

Pruning of symptomatic branches

Table 3 Overall effect of sweet orange variety, pruning method, HLB symptom severity, and age of the tree on success of eradicating HLB from infected trees

Parameter	Total Pruned trees	Trees that expressed symptoms after pruning	%
Variety Valencia	290	185	63.8
Variety Hamlin	141	78	55.3
Variety Pera	161	98	60.9
Chi-square 2.86 ($P = 0.2388$)			
Decapitation method	376	235	62.5
Branch removal method	216	126	58.3
Chi-square 1.00 ($P = 0.3171$)			
Asymptomatic	79	6	7.8
Symptoms at the end of the branch	109	64	58.7
Symptom on the entire branch	404	291	72.0
Chi-square 115.59 ($P < 0.0001$)			
3 year-old trees	51	36	70.6
5 year-old trees	307	185	60.3
9 year-old trees	161	98	60.9
16 year-old trees	73	42	57.5
Chi-square 2.41 ($P = 0.4917$)			

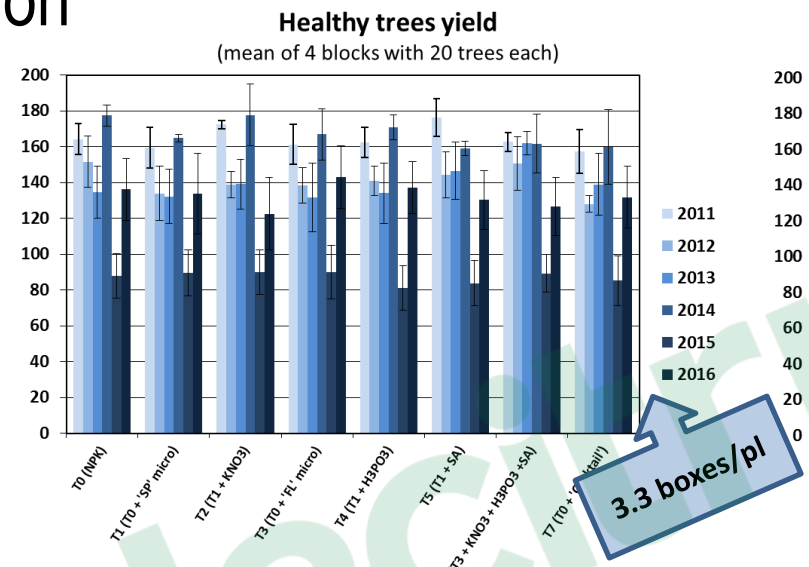
Lopes et al 2007

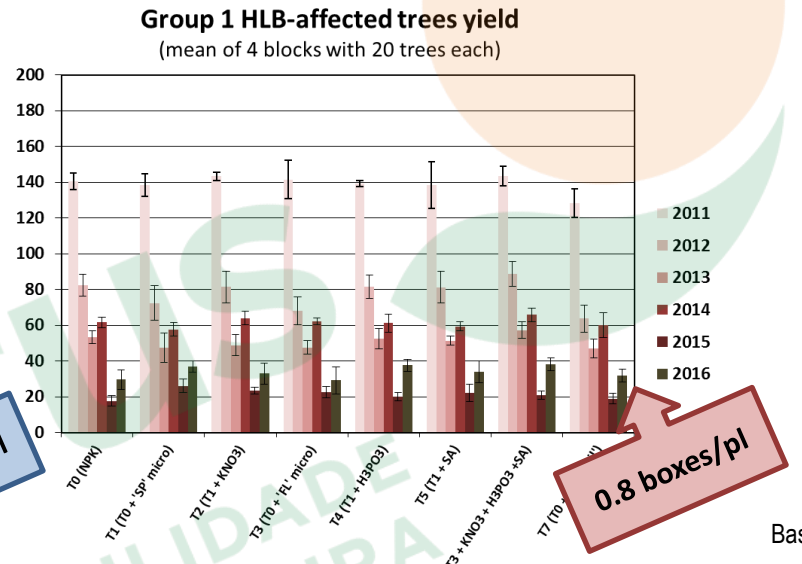
Thermotherapy (hot steam)

Attempts to cure and remission of symptoms

Enhanced nutrition

- Zn, Mn, B, KNO_3, phosphite, salycilate
- Ca, Mg and micronutrients
- Micronutrients, 2,4-D





15
45
64
63
75
75

Bassanezi et al 2016, 2019

Antimicrobials and systemic resistance inducers

Citrus Industry News

'No Positive Response' from Bactericides

Citrus Research and Development Foundation (CRDF) President Larry Black discusses grower trial results indicating bactericides used for HLB infection did not increase citrus yields. The results were presented by CRDF staff at a recent meeting of the organization.

UF IFAS UNIVERSITY of FLORIDA BLOGS

UF/IFAS Study: Oxytetracycline Sprays May Not Protect Citrus Trees From Greening Disease Effectively, Though Trunk Injections Show Promise

Field trials in FL (2016/17 and 2017/18)

Fruit yield: 2 ↑, 3 ↓ and 11 **ns** (16 sites)
Fruit drop: 1 ↑, 2 ↓ and 8 **ns** (11 sites)
Severity: 3 ↓, 7 ↑ and 38 **ns** (48 sites)
Bacteria: 5 ↓, 8 ↑ and 26 **ns** (39 sites)

Syvertsen, 2019

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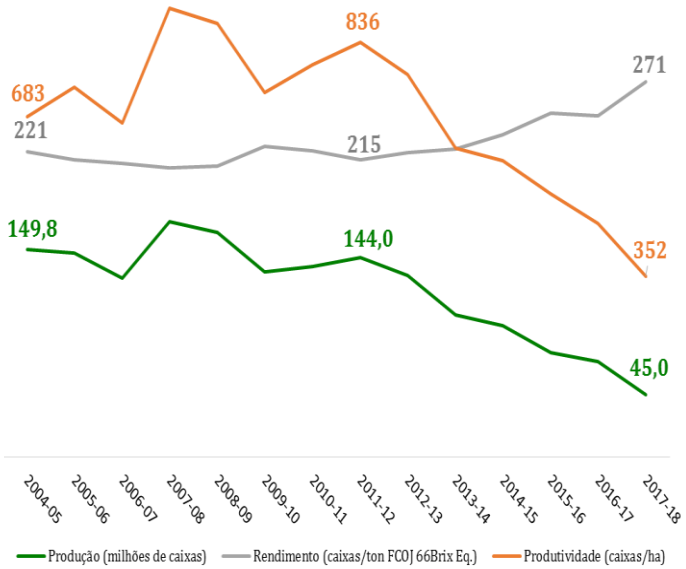
Results of living with HLB-diseased trees

Results of living with HLB-diseased trees in Florida (90% HLB)



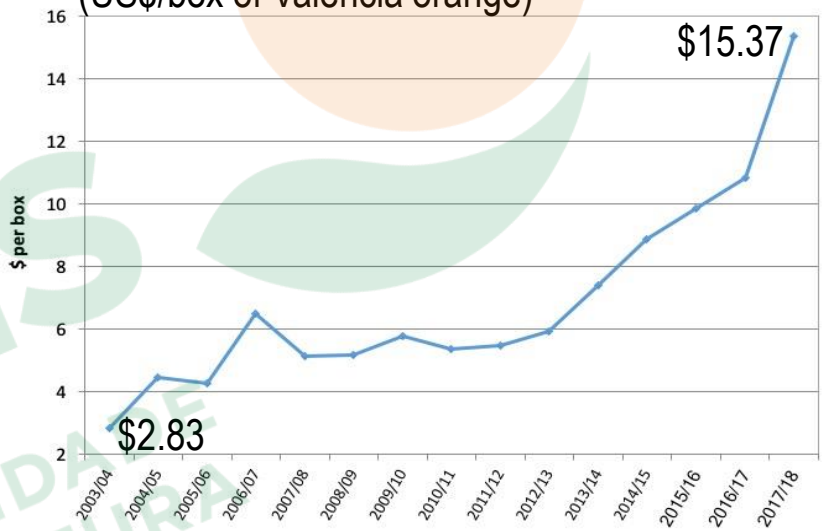
Source: U.S. Department of Agriculture-National Agricultural Statistics Service

Juice yield - 23%
(boxes/ton FCOJ)

Productivity - 48%
(boxes/ha)

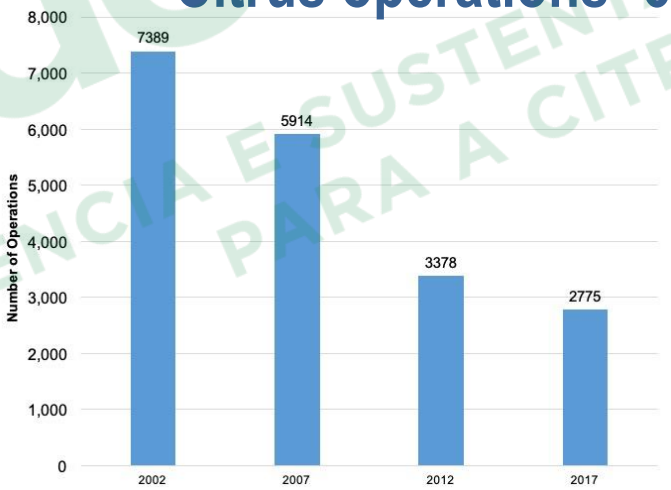
Production - 70%
(million boxes)

Production cost per box + 443%
(US$/box of Valencia orange)



German, UF/IFAS CREC

Citrus operations -62%

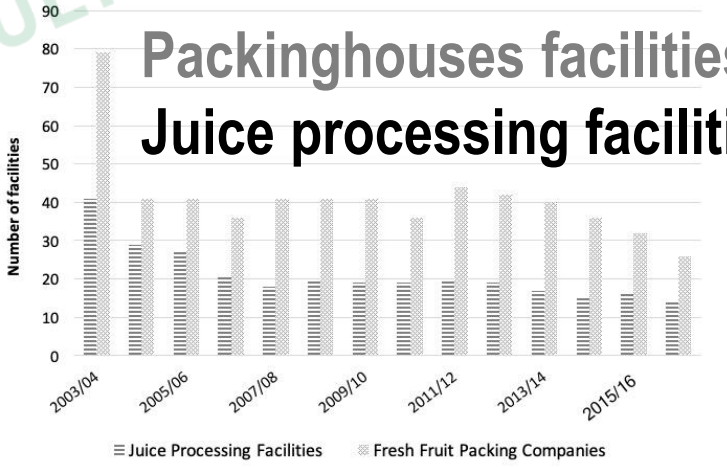


Source: U.S. Department of Agriculture – National Agricultural Statistics Service

Bearing citrus area - 41%
271,600 ha in 2003/04
160,800 ha in 2017/18

Packinghouses facilities - 66%

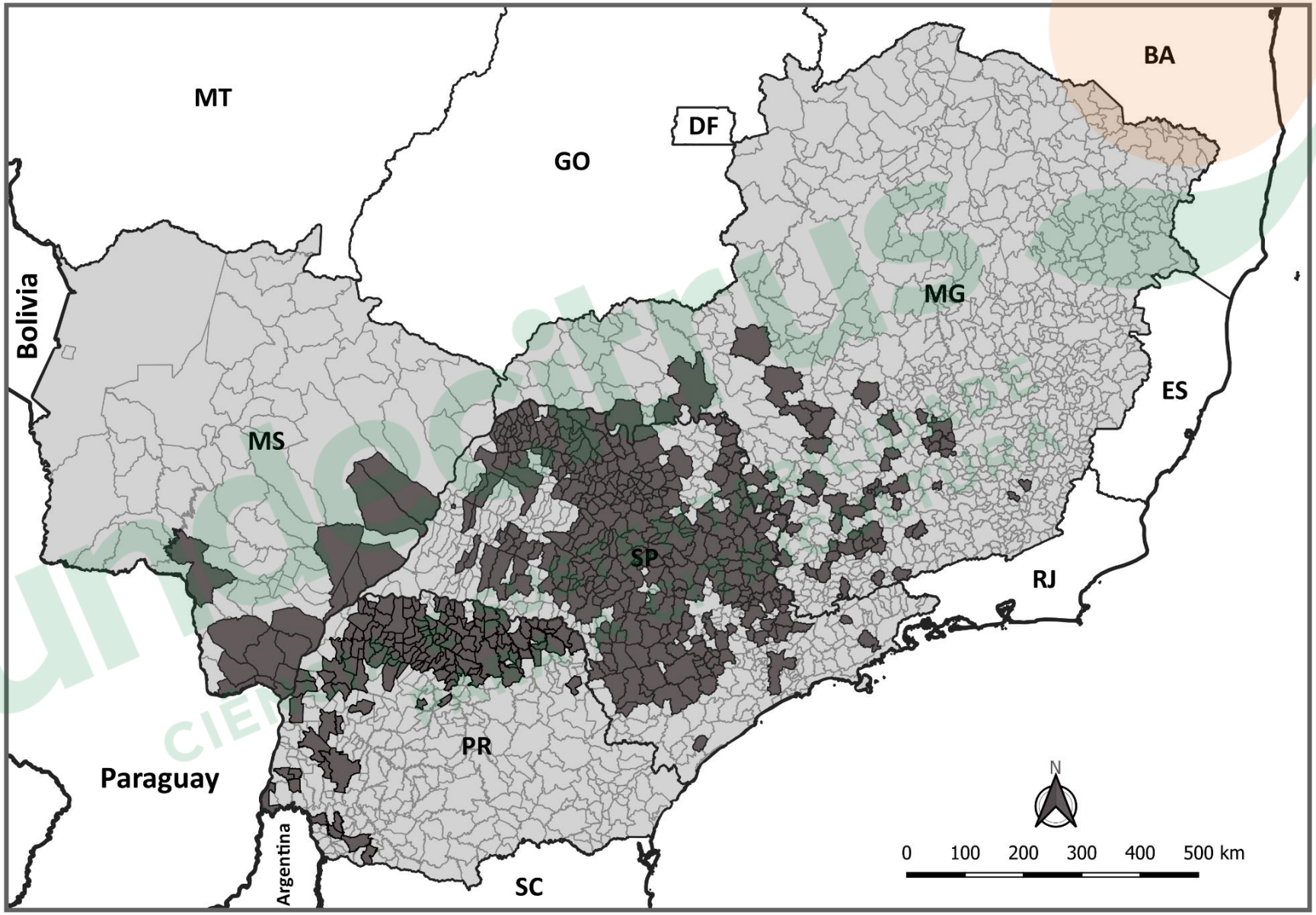
Juice processing facilities - 63%



Source: Florida Department of Agriculture and Consumer Services

HLB in Brazil

SP (2004)
MG (2005)
PR (2007)
MS (2019)



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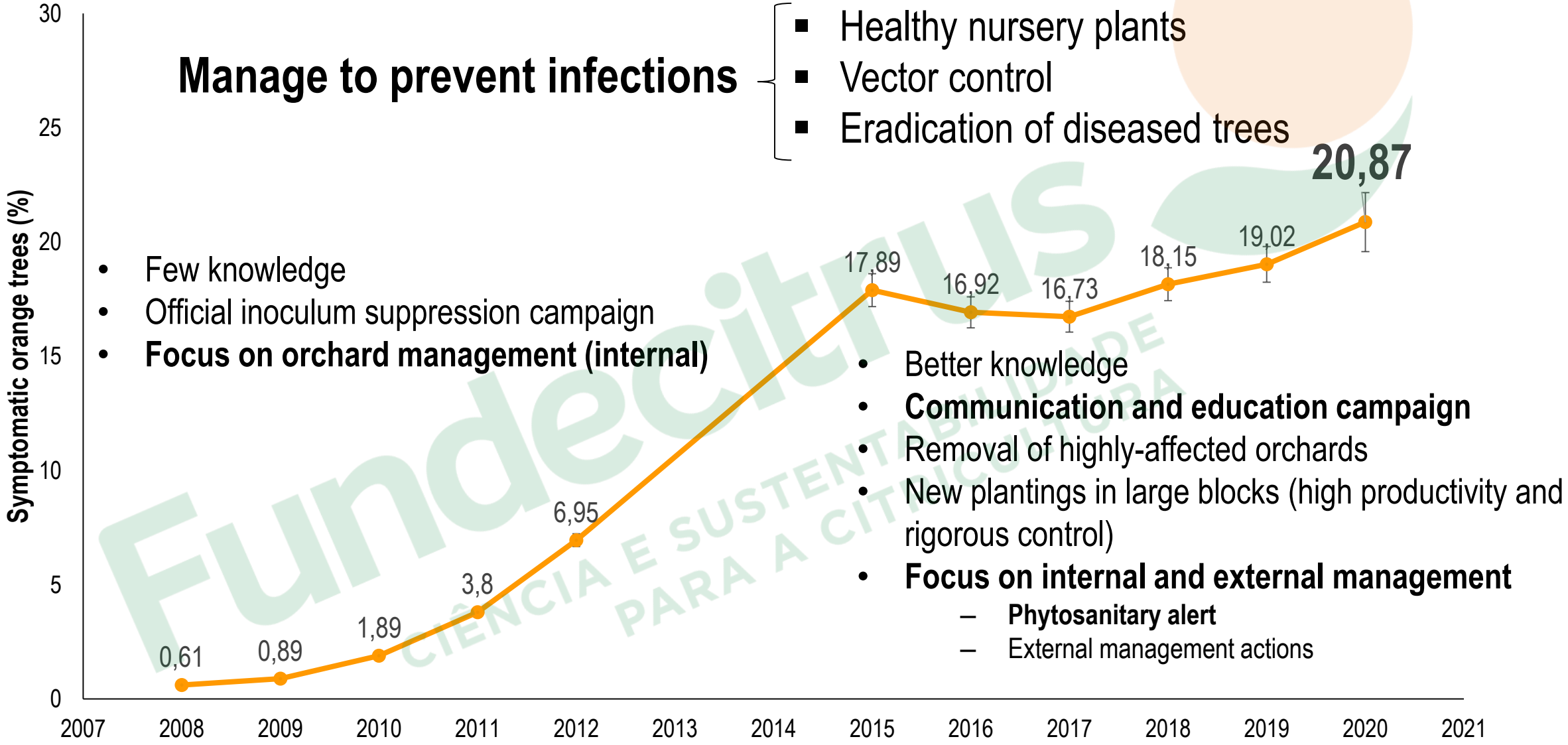
HLB in Sao Paulo citrus belt



Manage to prevent infections

- Healthy nursery plants
- Vector control
- Eradication of diseased trees

- Few knowledge
- Official inoculum suppression campaign
- **Focus on orchard management (internal)**

- Better knowledge
- **Communication and education campaign**
- Removal of highly-affected orchards
- New plantings in large blocks (high productivity and rigorous control)
- **Focus on internal and external management**
  - **Phytosanitary alert**
  - External management actions

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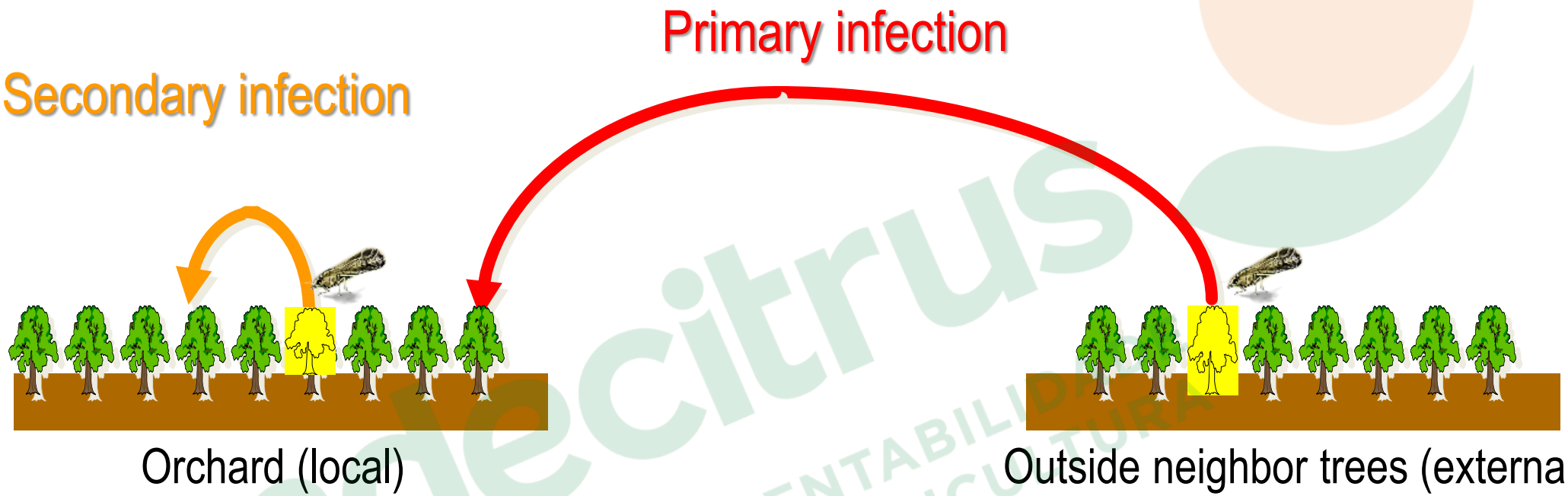
Factors that make it difficult to control HLB

- ✓ Absence of resistant/tolerant commercial varieties
- ✓ Absence of effective and viable curative measures
- ✓ Long incubation period and short latency period
- ✓ Resistance of growers to eliminate diseased trees
- ✓ Inoculum source outside commercial orchards
- ✓ Long distance dispersion of the psyllid
- ✓ Difficulty in preventing primary infections

Primary and secondary infections



Prevent ACP life cycle from completing (14 to 47 days)
Prevent adult ACP from feeding on diseased trees
Prevent bacteria latency period from completing in the ACP (10 to 21 days)

Easier to achieve with local control

Frequent insecticide sprays and diseased tree removal

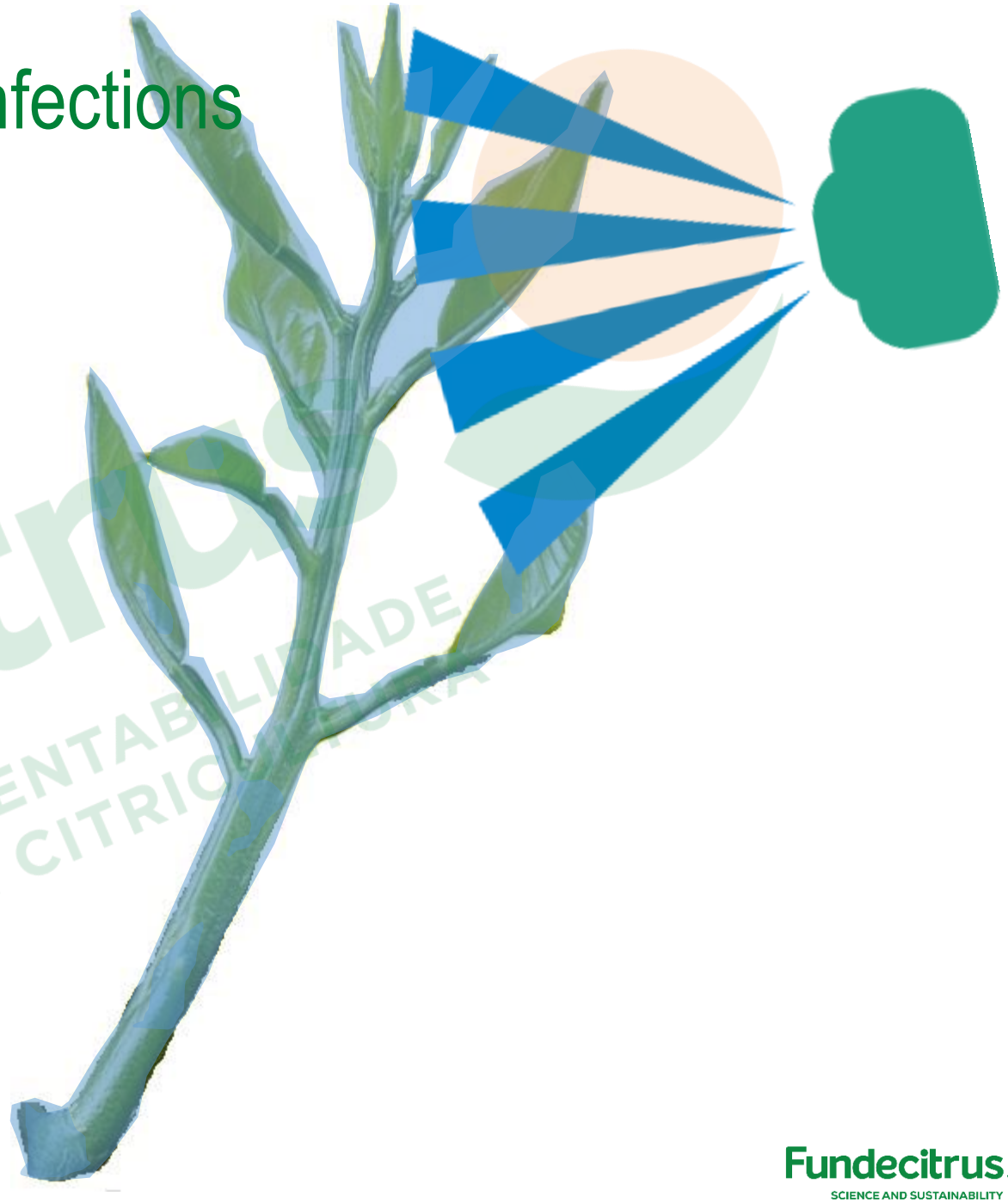
Prevent infective ACP from feeding in heathy trees

Harder to achieve with local control

Difficulty of controlling primary infections

The new shoot must be always protected by the insecticide sprayed

Difficulty of controlling primary infections



The new shoot must be always protected by the insecticide sprayed

Shoot groth reduces the insecticide coverage and opens Windows for infection

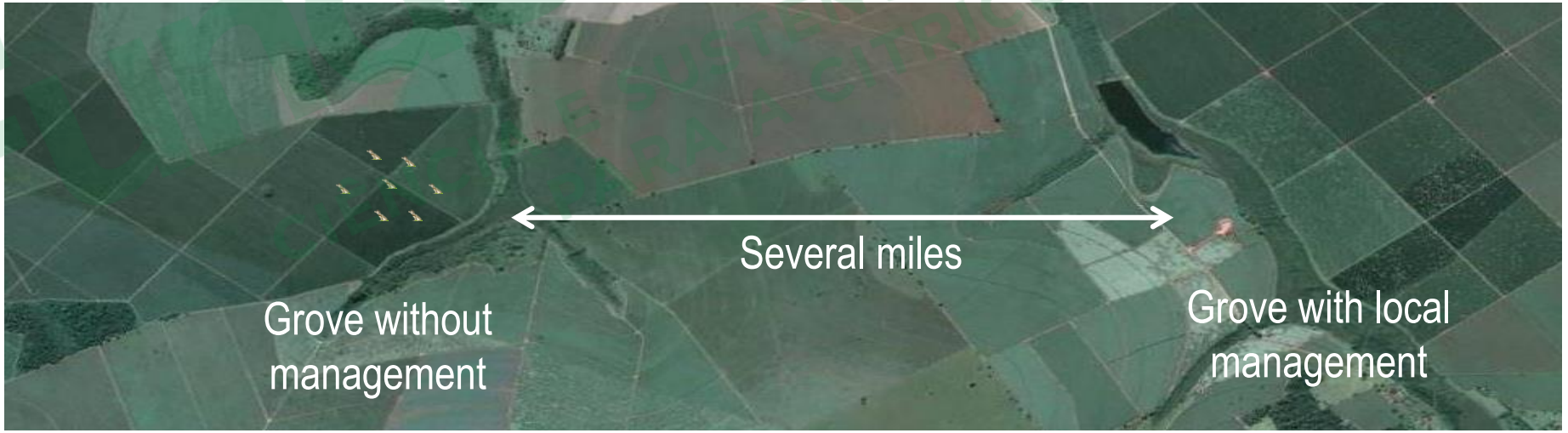
High frequency of spraying during shoot growth and rainy season

Psyllid dispersal and importance of regional management

- **ACP are always looking for new shoots and can disperse at long distance**
  - No citrus orchard is isolated
  - Adult psyllids reared in a HLB-affected tree can arrive everyday in commercial orchards

- **Even with frequent local insecticide sprays it is very difficult to completely avoid that infective ACP** emigrates and **transmits the pathogen** before be killed by the applied insecticide

- **Progress of HLB** in the orchard **depends on local and REGIONAL control of ACP and inoculum sources**



1. Planting and reseting planning

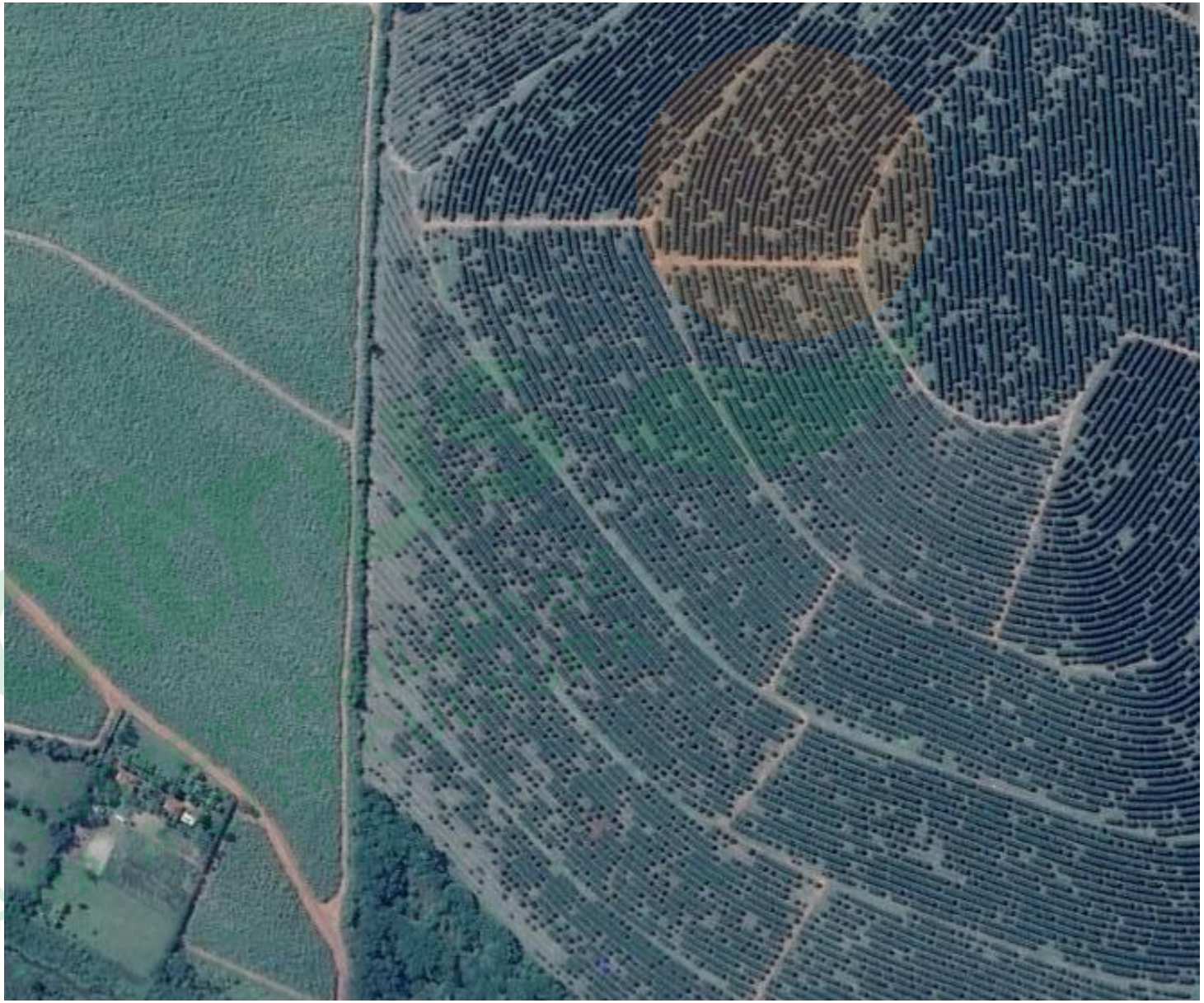
“ The onset of the epidemic should be delayed as much as possible”

- **Planting site selection**
  - Avoid region with high HLB incidence
  - Avoid area without regional disease management
  - Avoid planting next to older orchards without HLB management

Edge effect

The first 100 to 200 m from the border is the area most exposed to infectious psyllids that constantly arrive from other diseased citrus plants in abandoned orchards and orchards with no psyllid control

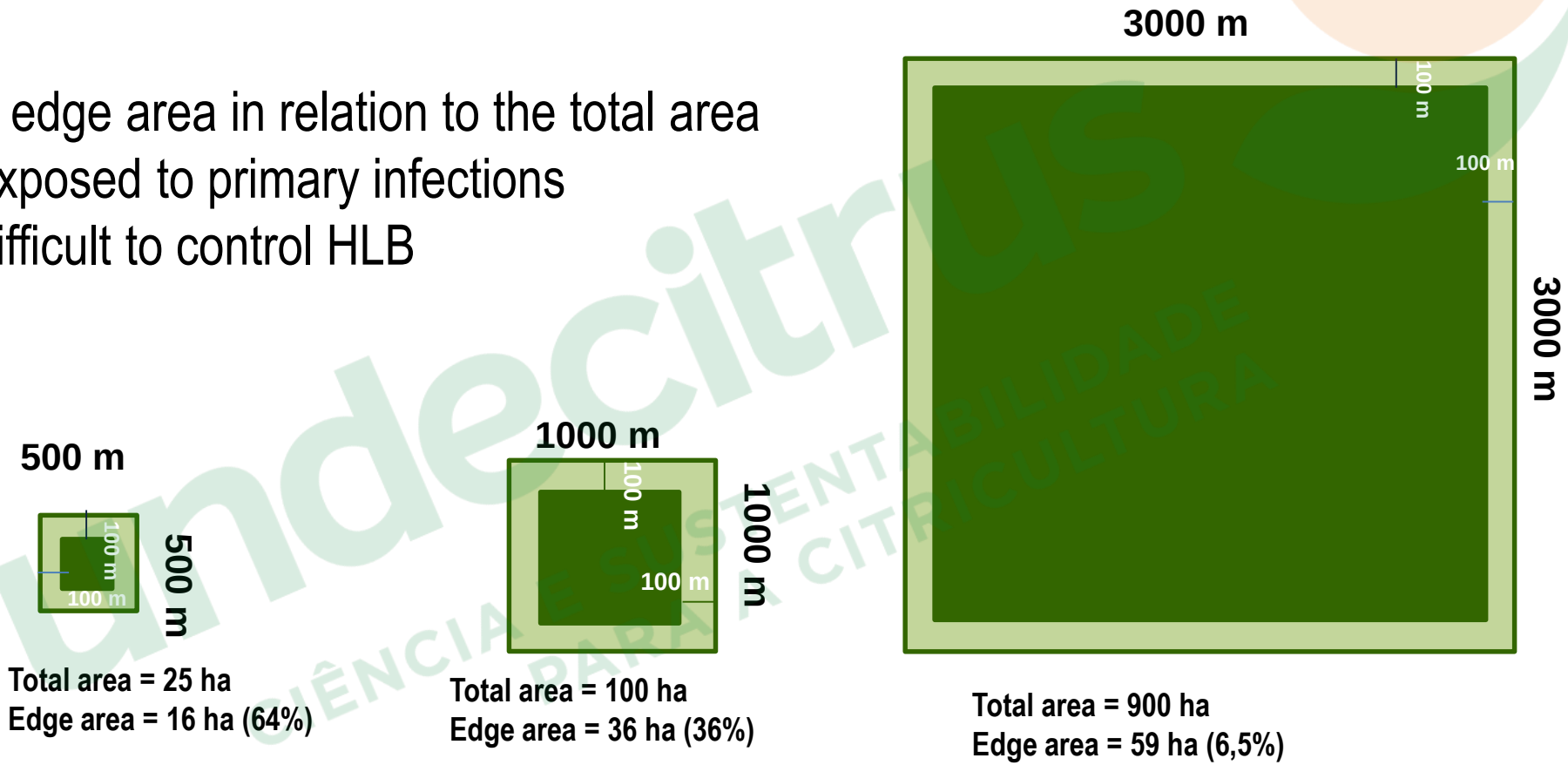
This is where most primary infections occur, which are difficult to avoid due to the need for total protection of the new shoot during its growth phase



Edge effect and primary infection as fuction of orchard size

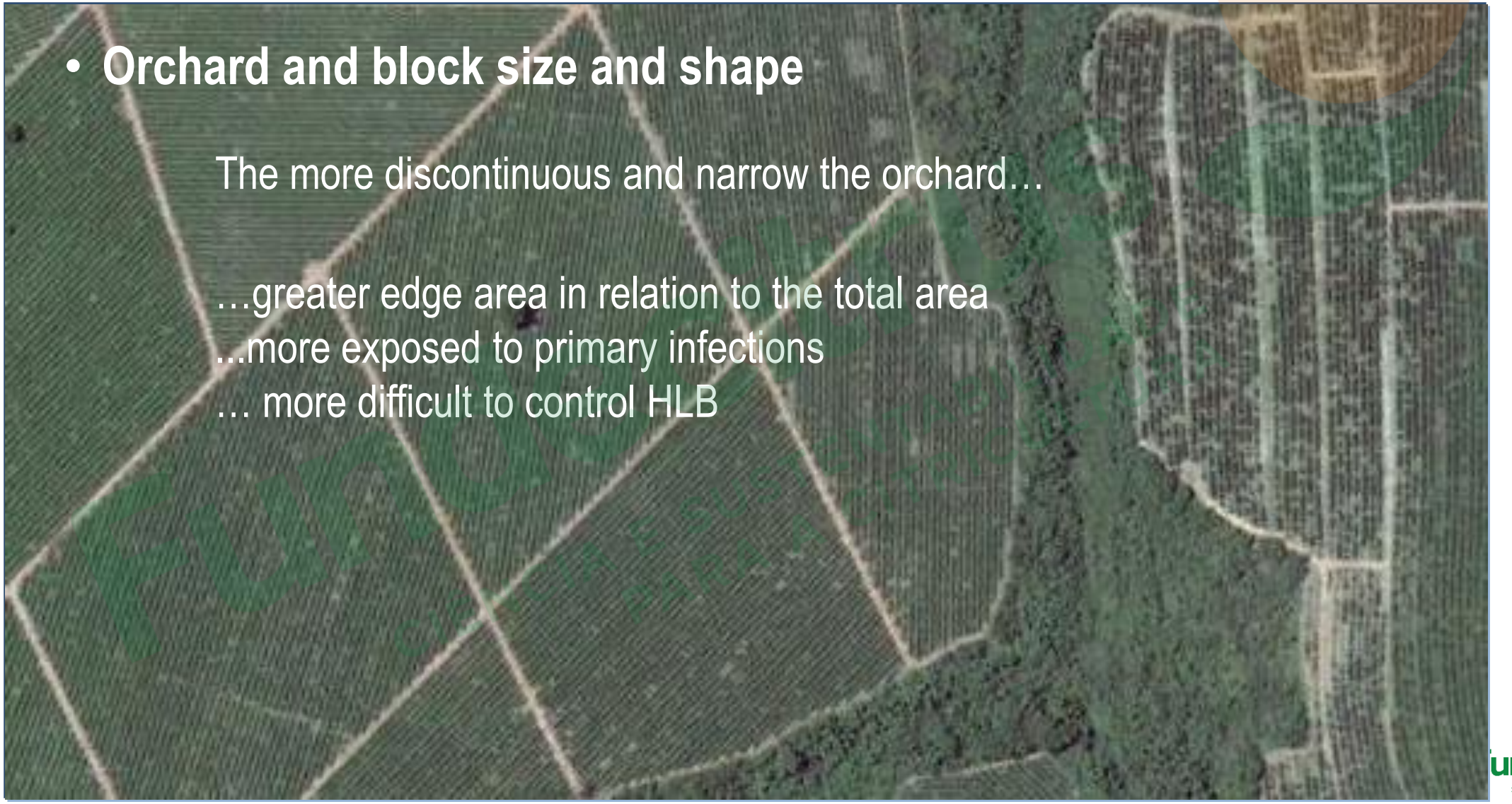
The smaller the orchard ...

…greater edge area in relation to the total area
…more exposed to primary infections
…more difficult to control HLB



1. Planting and reseting planning

"New plantings must be prepared to facilitate the control of HLB and reduce its damage"



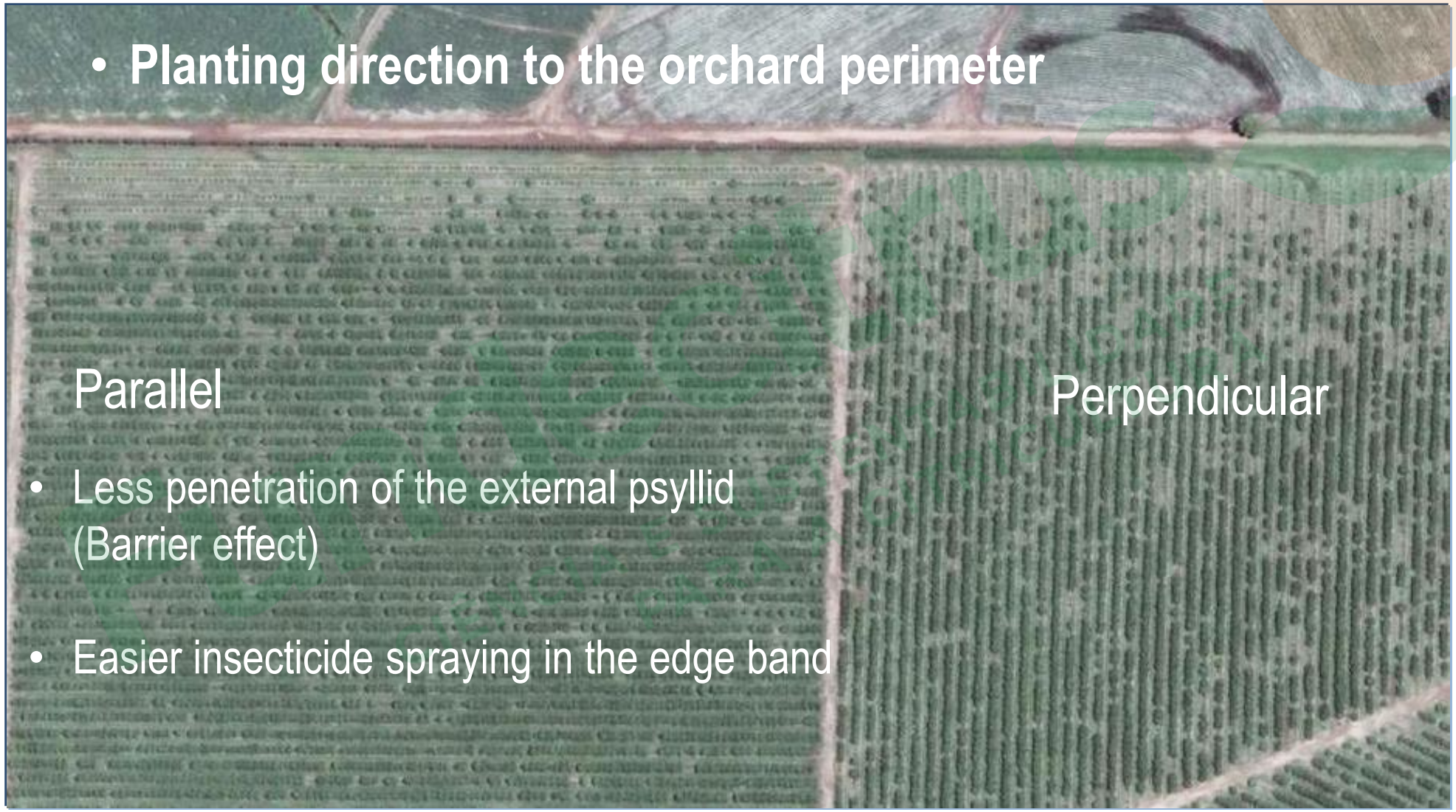
- **Orchard and block size and shape**

The more discontinuous and narrow the orchard…

…greater edge area in relation to the total area
...more exposed to primary infections
… more difficult to control HLB

1. Planting and reseting plan

"New plantings must be prepared to facilitate the control of HLB and reduce its damage"



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2. More intensive management in the orchard edge

“ It must prevent the penetration of the psyllid into the orchard”

3. Planting healthy nursery plants

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4. Growth and yield speed up

"Escape the most susceptible stage of the plant"

- Best practices:
  - -Quality of nursery plants
  - -Scion/Rootstock combination (high density, harvest, pest and disease inspection and control)
  - -Planting density (barrier effect, production antecipation and compensation)
  - -Irrigation
  - -Good nutrition

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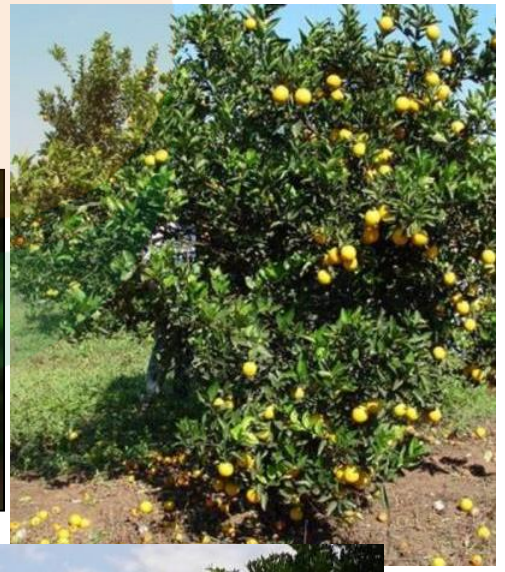
5/6. Detection and removal of diseased trees

“Diseased trees are sources of bacteria that can be taken to healthy trees by psyllids"
"The greater the number of diseased trees in the field, the stricter the vector control must be"

- Recognition of plants with symptoms
  - Training, recycling and auditing of teams
- Inspection methods
- Inspection and removal frequency
  - For first detection:
    - » Plots and plants from the periphery
    - » Young orchards
  - For suppression:
    - » All plots
    - » From the second year
    - » Minimum 4x per year
    - » End of rains until beginning of rains





7/8. Vector monitoring and control








"Diaphorina citri must be controlled as a vector and not as a pest"

Zero tolerance

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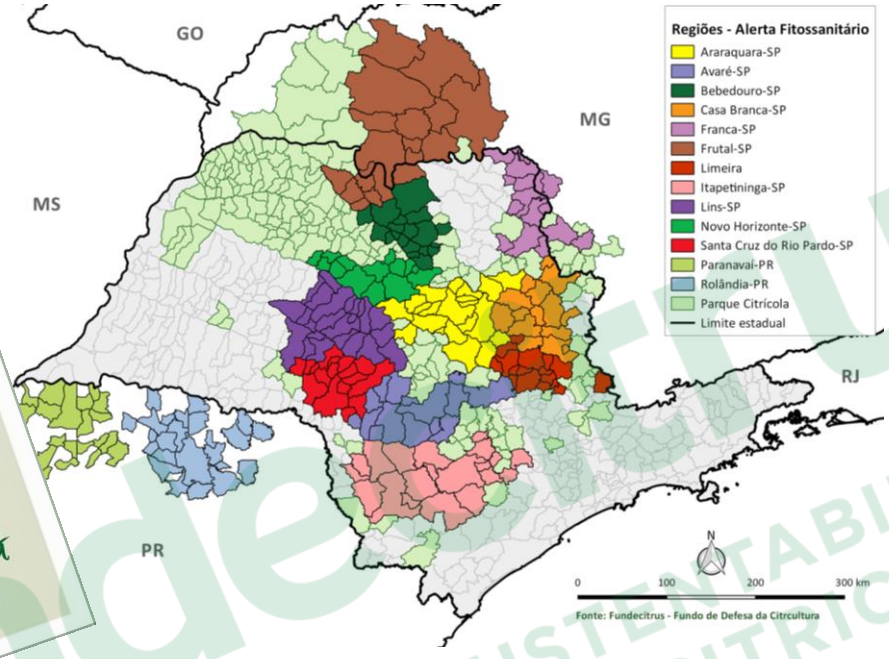
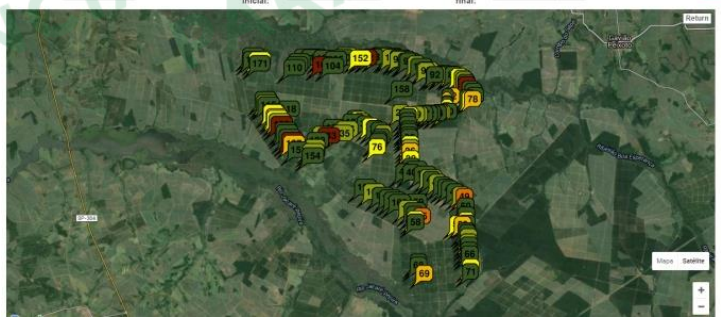
9. Area wide psyllid control – Phytosanitary alert

- Regional monitoring of the psyllid population and coordinated and simultaneous insecticide spray by all growers





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10. External management actions

"Few Citrus and Murraya trees can host many infective psyllids and cause severe epidemics in the comercial orchards"

- Partnership among neighboring growers to eliminate external sources of inoculum

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HLB Integrated Management

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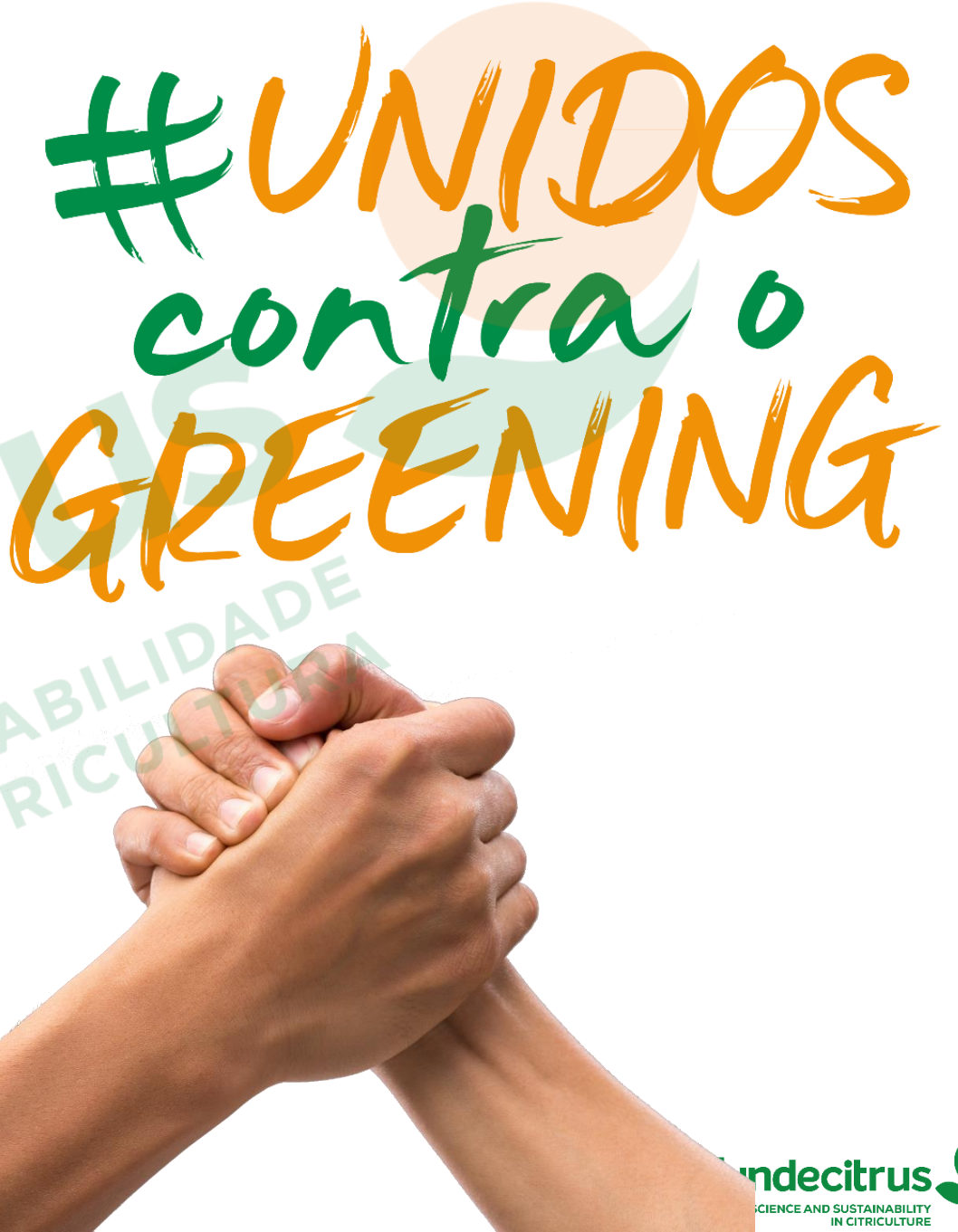
Challenges for HLB control

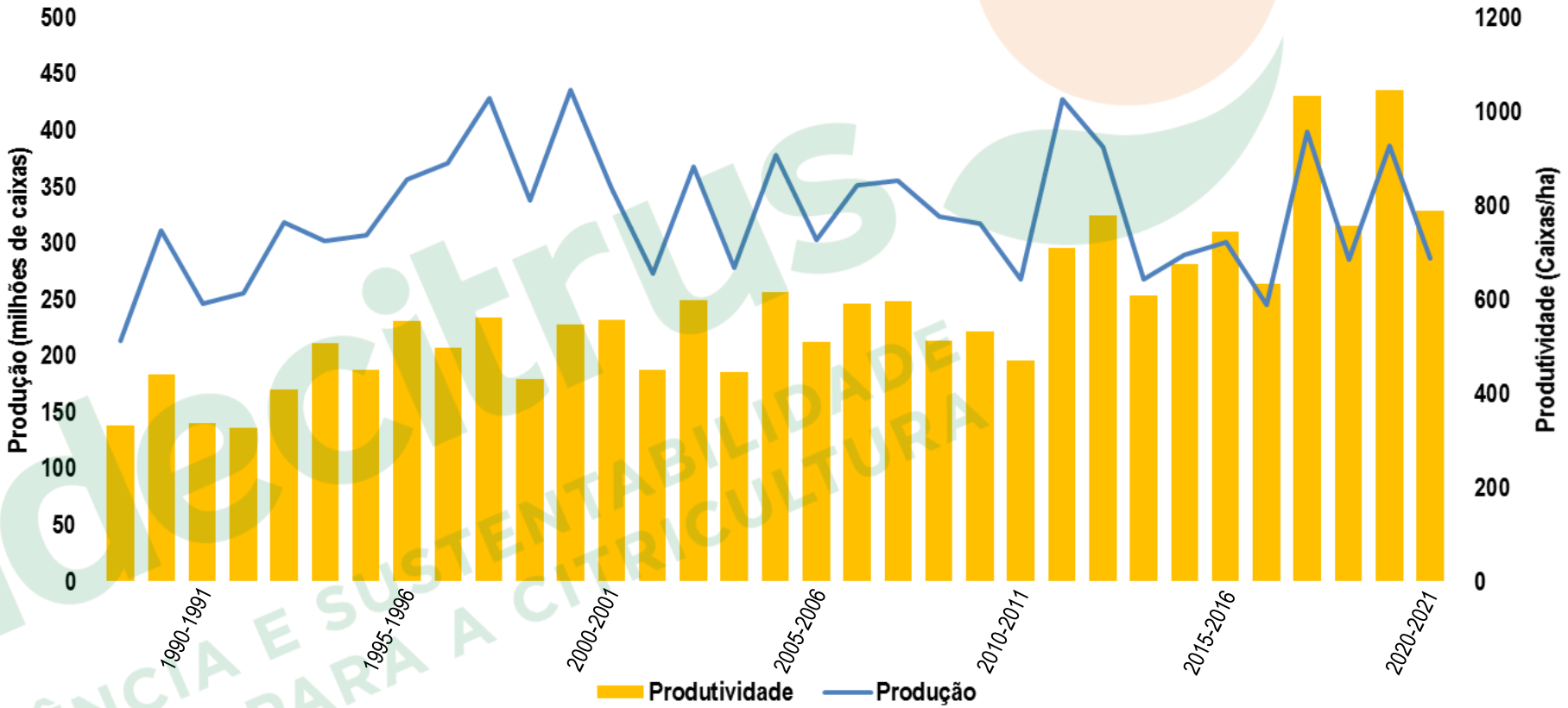
- ✓Adherence of citrus growers in the management
- ✓External inoculum sources
- ✓Sustainability of current management
- ✓Resistant varieties or cure for diseased trees



HLB impact in Sao Paulo citrus belt

- ✓ Increase of costs (15 to 25%)
- ✓ Eradication of trees (55.6 million from 2005 to 2019)
- ✓ Yield loss in abandoned and no managed orchards
- ✓ Reduction of new plantings (-72% from 2005 to 2018)
- ✓ Reduction of citrus area (-25% from 2005 to 2018)
- ✓ Exit of growers (-23% from 2015 to 2018)

Orange production and yield in Sao Paulo citrus belt



Fonte: CitrusBR e IBGE (1988-1989 a 2014-2015) Fundecitrus (2015-20019) Estimativa Fundecitrus (2020)

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Thank you!

renato.bassanezi@fundecitrus.com.br

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@Fundecitrus

+55 16 997611091