

Greening Brazil Experiences

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Cambuhy Farm Project



- Farm is about 35.000 acres with 20.000 acres of citrus

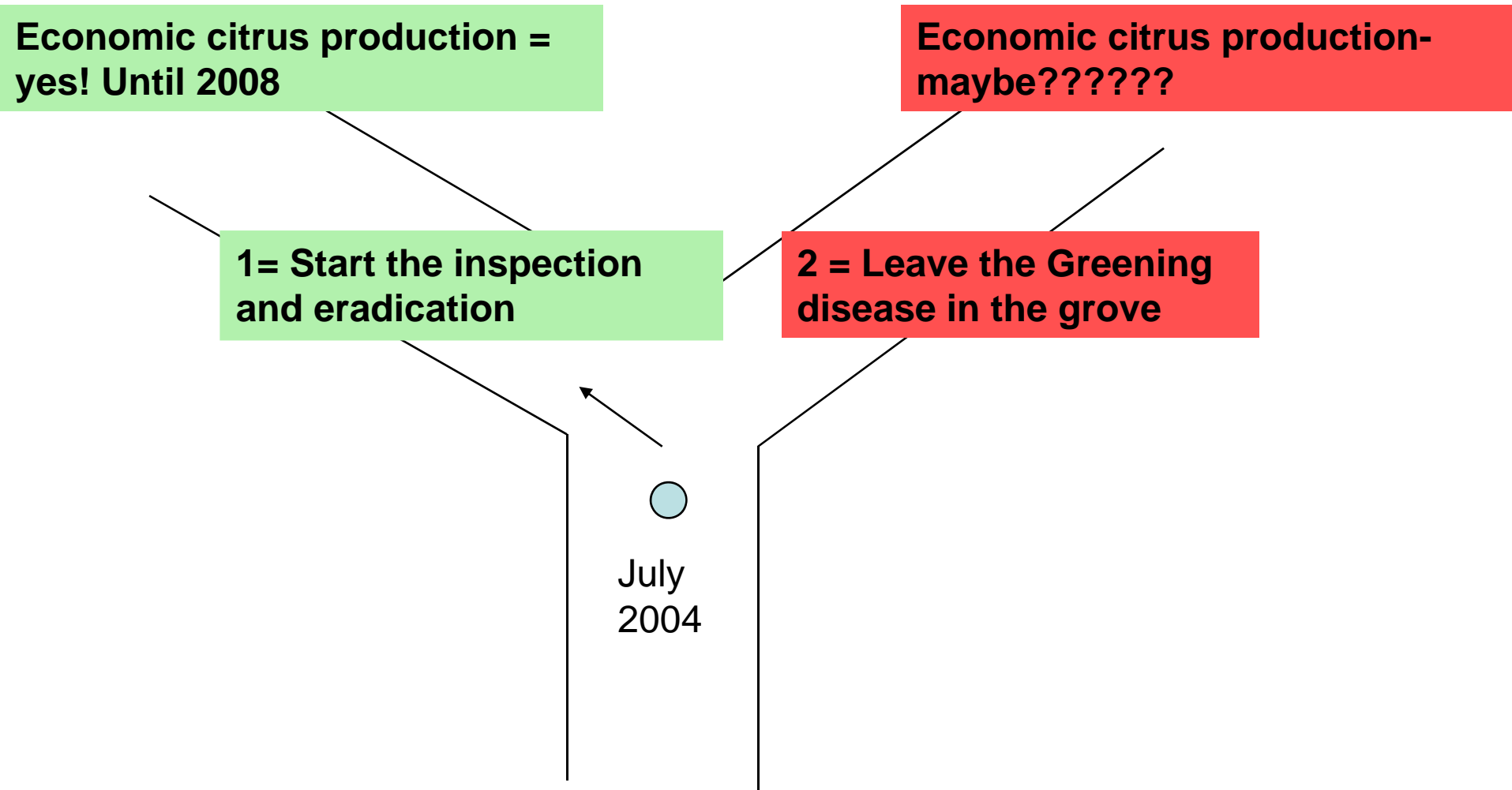
- Citrus production is about 5 million boxes, fully used for processing

- The farm also produces coffee, rubber and sugar cane

- Preserved 10.000 acres (31%) of natural forest within the farm



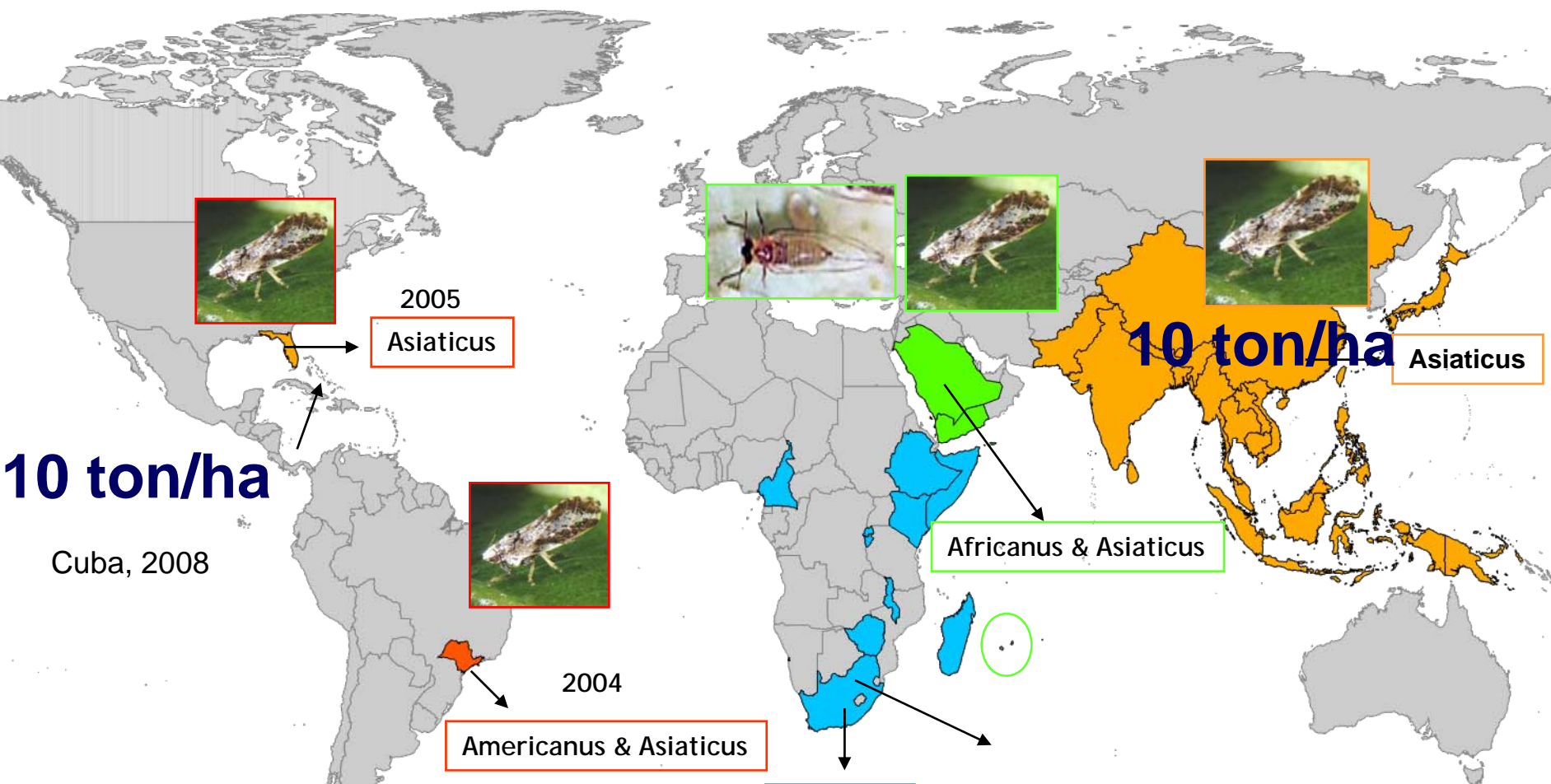
4 years ago: 2 decisions



Why Greening is risk to citriculture ?

- Increase costs (inspection, eradication, vector control)
- Reduce directly the production (removed plants).
- High reset % is expensive (high costs to remove and reset plants).
- The actual Greening management technology in terms of vector control, inspection and eradication could not guarantee citrus remains economic production (mainly to the small and medium citrus grower localized in high Greening incidence region).

Citrus yield under Greening incidence in the world



10 ton/ha

Cuba, 2008

2005
Asiaticus

2004
Americanus & Asiaticus

Africanus

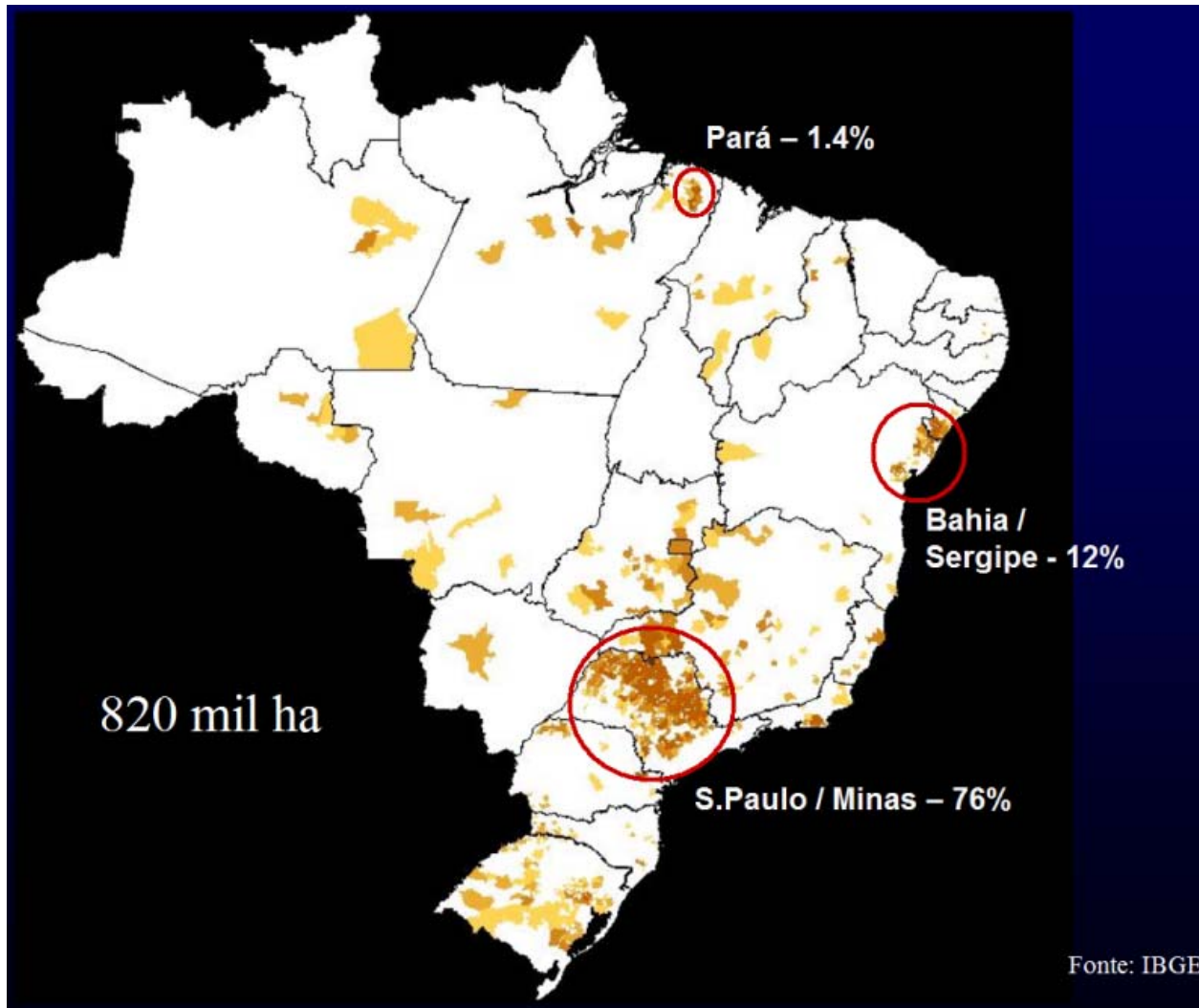
Africanus & Asiaticus

10 ton/ha
Asiaticus

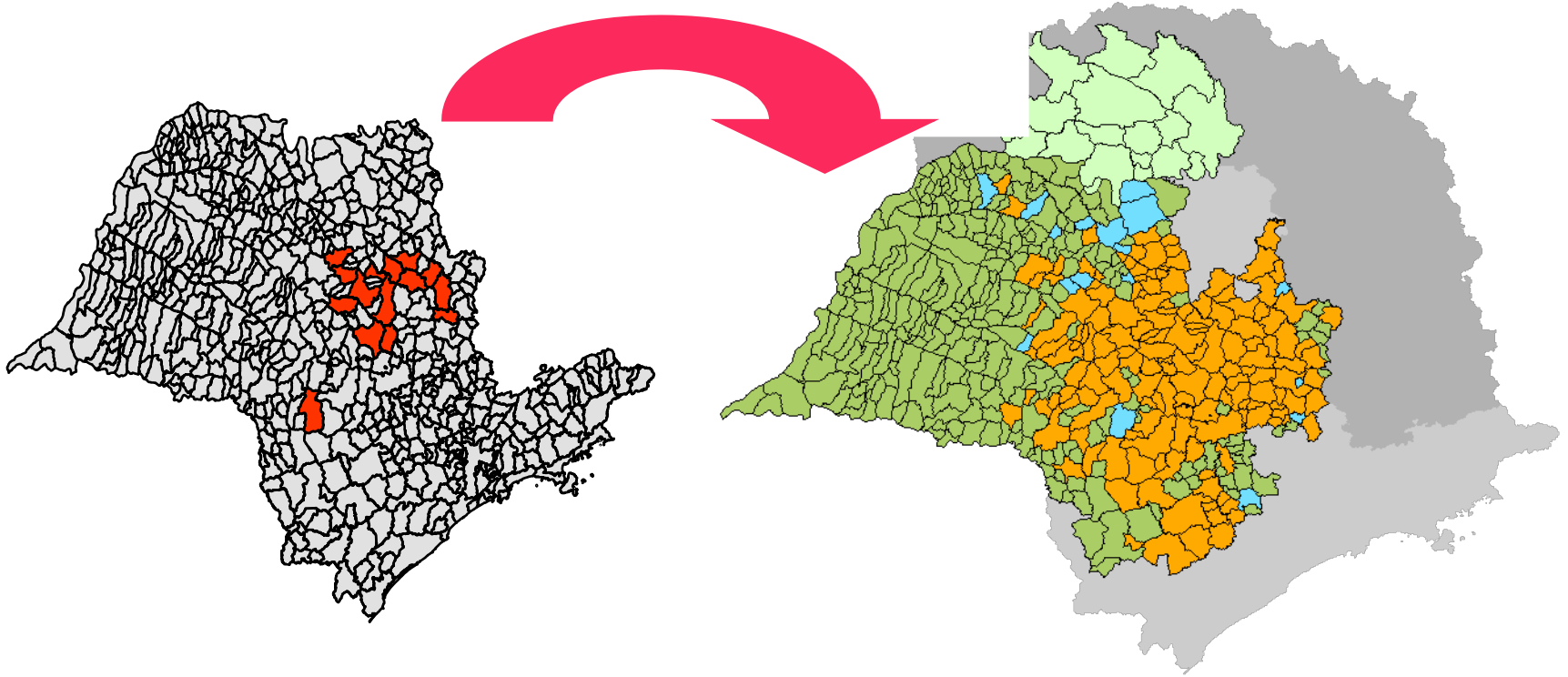
50 ton/ha = Greening "light" version, the bacteria and the vector die during the summer
Same regions without the bacteria



Brazil - Orange production area



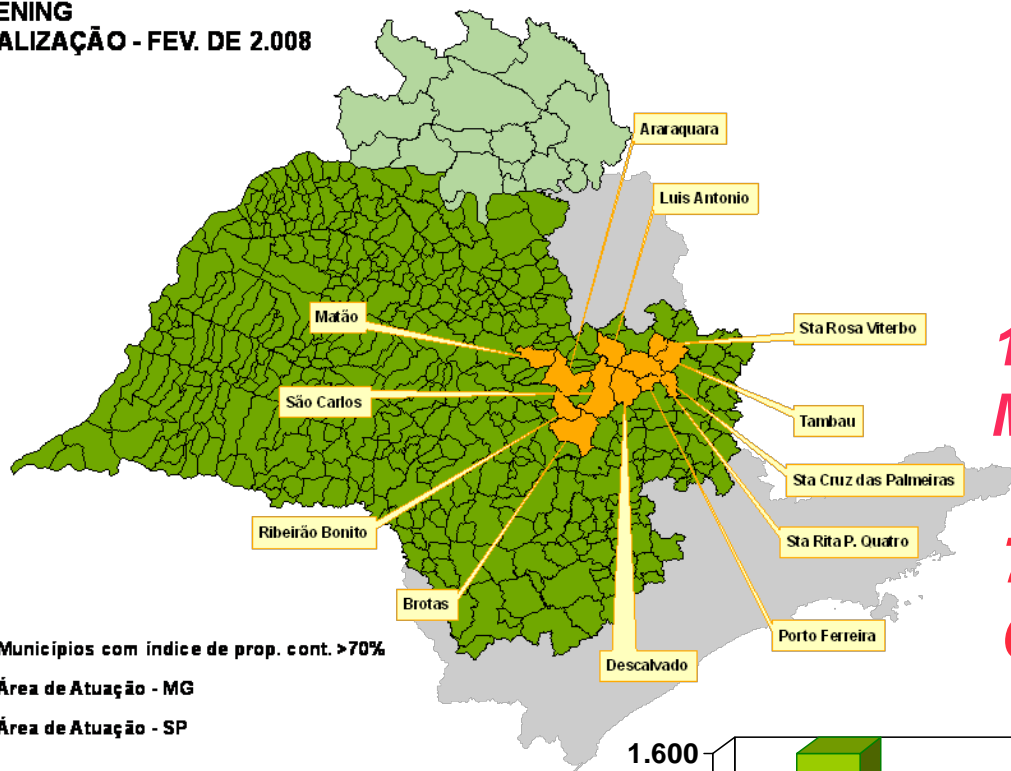
São Paulo State Greening incidence 2004 x 2008



15 Municipal districts
2004

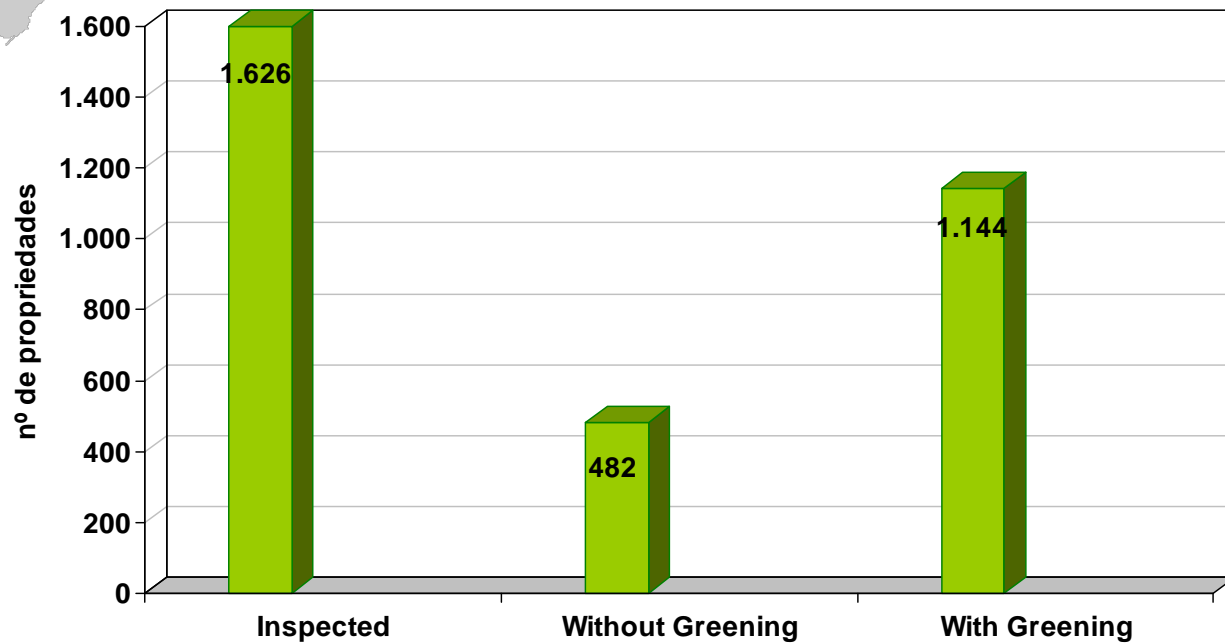
160 Municipal districts
2008

**GREENING
FISCALIZAÇÃO - FEV. DE 2.008**



**12 worst São Paulo
Municipal districts**

**70.36% of citrus farm with
Greening**



Brazil: 3 situations

- Growers **doing little** (probably 65% of the total)
- Growers **doing low level** of inspection and vector control (probably 10% of the total)
- Growers **doing good level** of inspection and vector control (probably 25% of the total)

Farms incidence example in the worst Greening incidence area.

Farm name	Total plants number	% of eradication	Major problem
Cambuhy	2,500,000	<i>0.9</i>	40 “bad” Neighbor
Agrindus	280,000	<i>4.5</i>	Small farm with 3 “bad” Neighbor
Farm C	180,000	<i>18.6</i>	Walking inspection
Farm D	1,200,000	<i>2.15</i>	Walking inspection
Farm E	1,000,000	<i>6.19</i>	Walking inspection
Farm F	4,000,000	<i>7.0 average. 1 farm 40%, 1 farm 100%.</i>	Delay to start control
Farm G	450,000	<i>3.2</i>	High initial incidence
Farm H	730,000	<i>2.14</i>	Walking inspection
Farm I	600,000	<i>40</i> <i>Lot of blocks with 100% of infection</i>	Bad Vector Control – Don’t have regular inspection

Formula 1 = high Greening incidence in 4 years (region with high incidence)

- Low vector control.
- Orchard without inspection.
- Orchard without eradication.

Formula 2 = keep low Greening eradication rates in 4 years (region with high incidence).

- High vector control.
- High inspection frequency
- Trained inspector
- Quick infected plant eradication

Remember: Based in only 4 years of experience. It is not total guarantee if you apply the formula 2 you will keep low Greening rates.

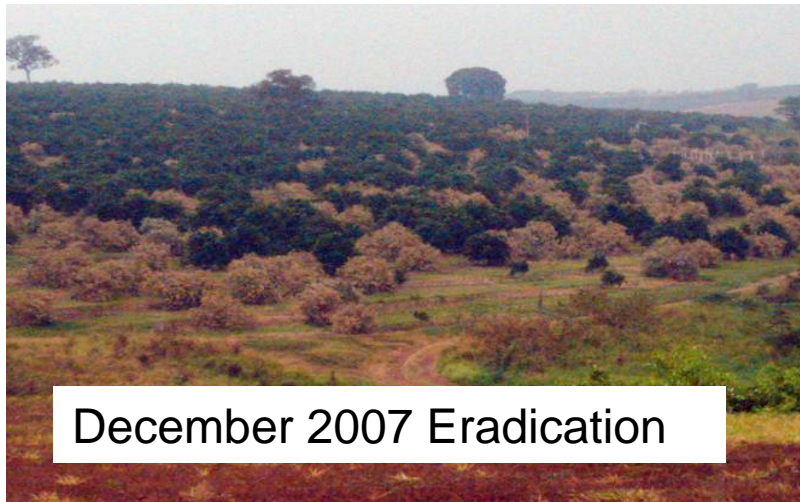
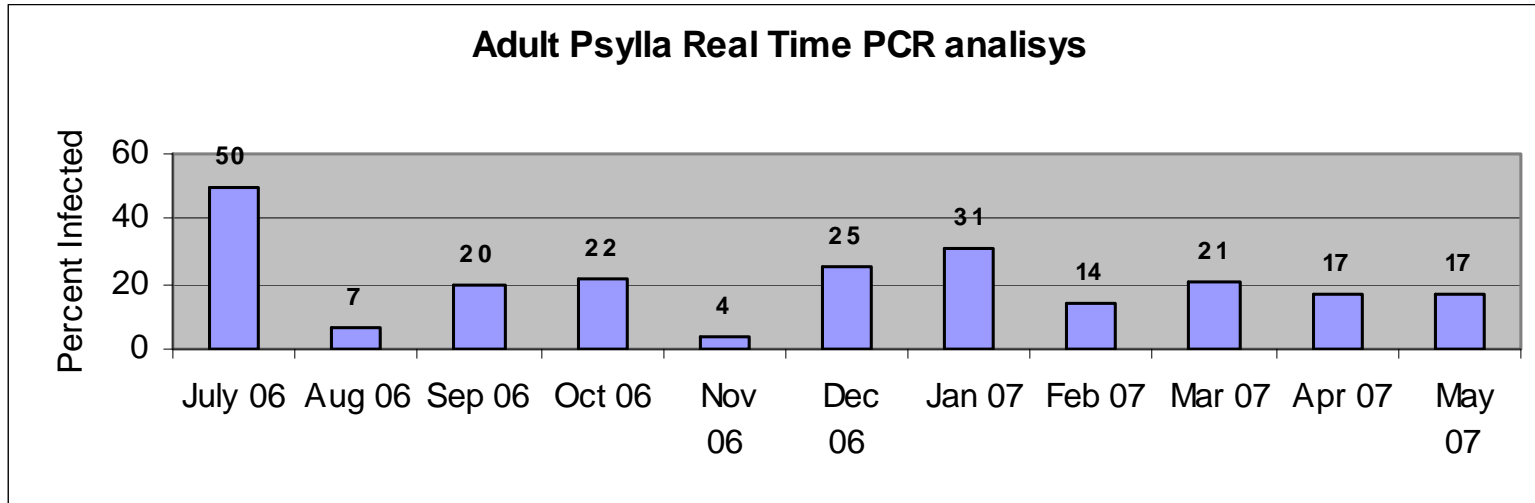
Two different scenarios in the São Paulo State Greening worst area

The way to survive economically and try to stay in the Brazilian citrus business

Taking 5 Farms for example:

3 with low Greening control & 2 with high Greening Control

Farm number 1 - Matão - about 20% eradicated plants, same blocks with 100% of infection.



December 2007 Eradication

Weekly PCR Test were made in USDA California by Drs. Manjunath and Lee.

Farm Number 2 – Araraquara – 100% Eradicated plant – progression of Greening in 3 yr old orchard

Hamlin

9 months later



August/2004

0.6%

May/2005

27.4%



1.5 yr old plant
with Greening

Farm Number 3 – Descalvado – 40% Eradicated plant – wait 3 years without any kind of control to start the inspection + eradication



Farm number 4 : Cambuhy Farm

- 
- Farm is about 35,000 acres with 20,000 acres of citrus.
 - 2,500,000 citrus trees.
 - Citrus production is about 5 million boxes, fully used for processing
 - 103 tractors
 - 1,600 staff working direct with citrus (including harvest).

Cambuhy: The 2 mainly diseases: CVC & GREENING

Direct annual CVC losses



US\$ 3,200,000/year

**80 bx/acre/year x 10,000 acres
ha = 800,000 boxes x US\$
4.00/box .**

Direct annual GREENING losses (***)

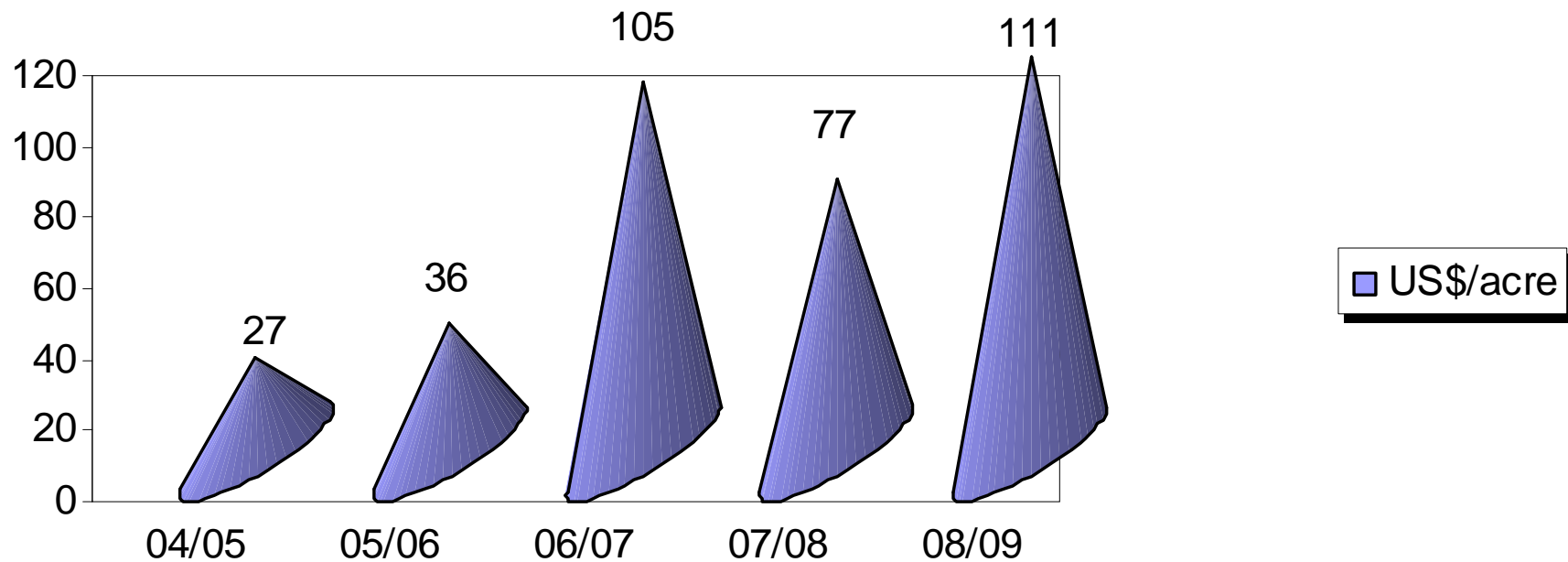


US\$ 48,000/year

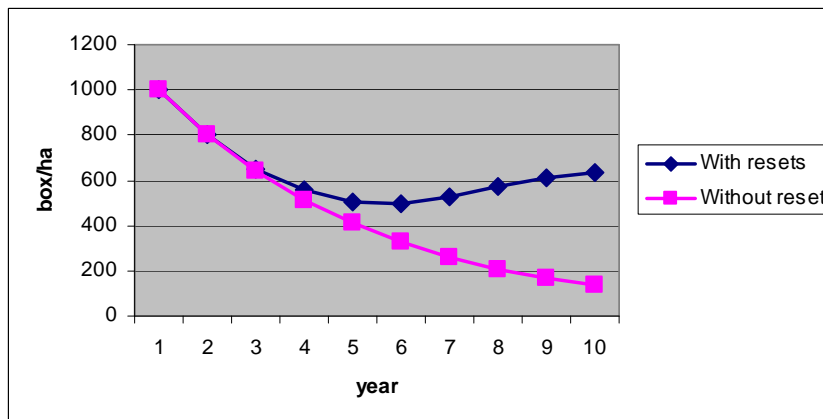
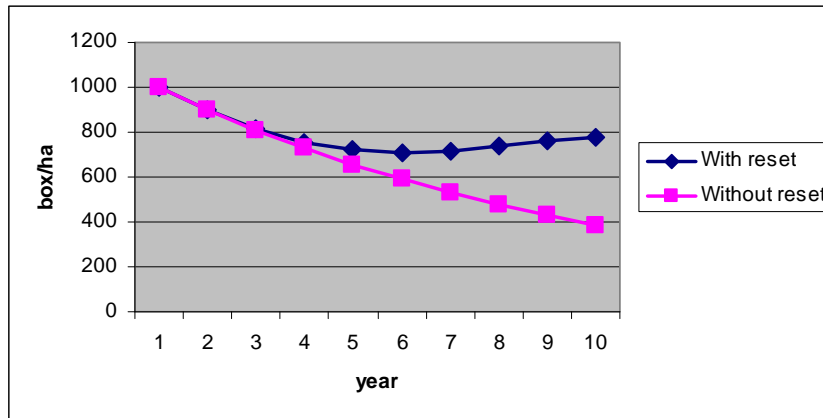
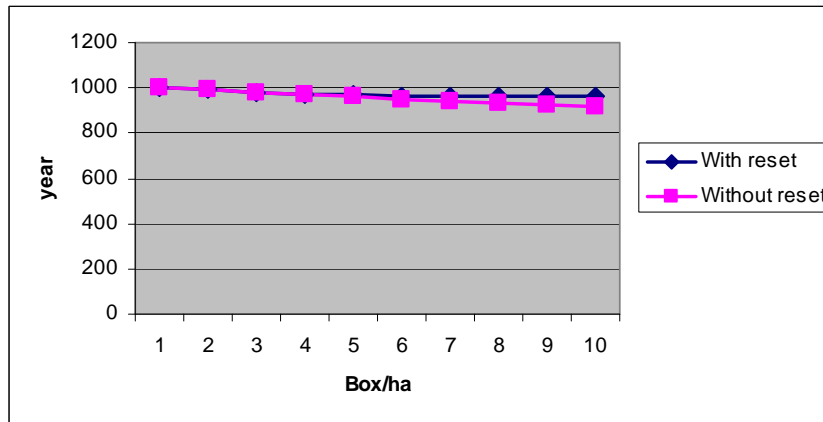
**6,000 plants/year x 2 box/plant =
12,000 box/year x US\$ 4.00/box**

***** high Greening management**

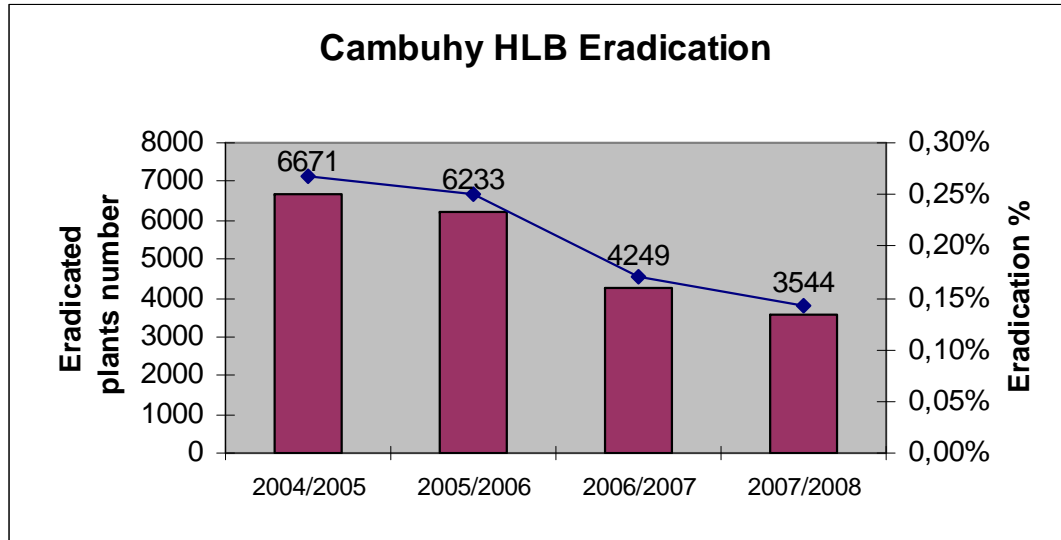
Cambuhy Insecticide (+ scale control) Cost/season



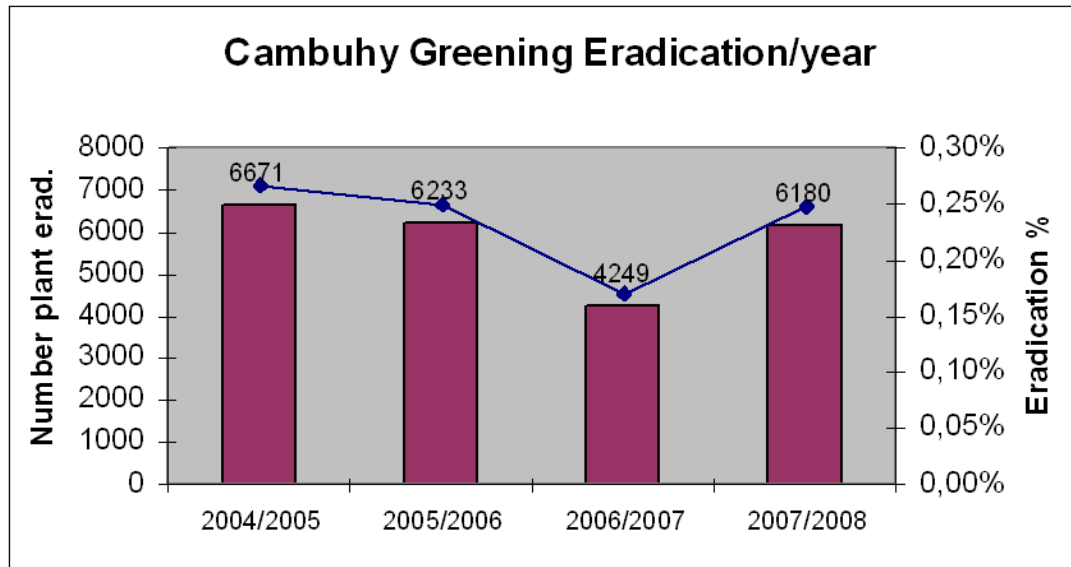
Greening – Risk to the citriculture profit and viability.



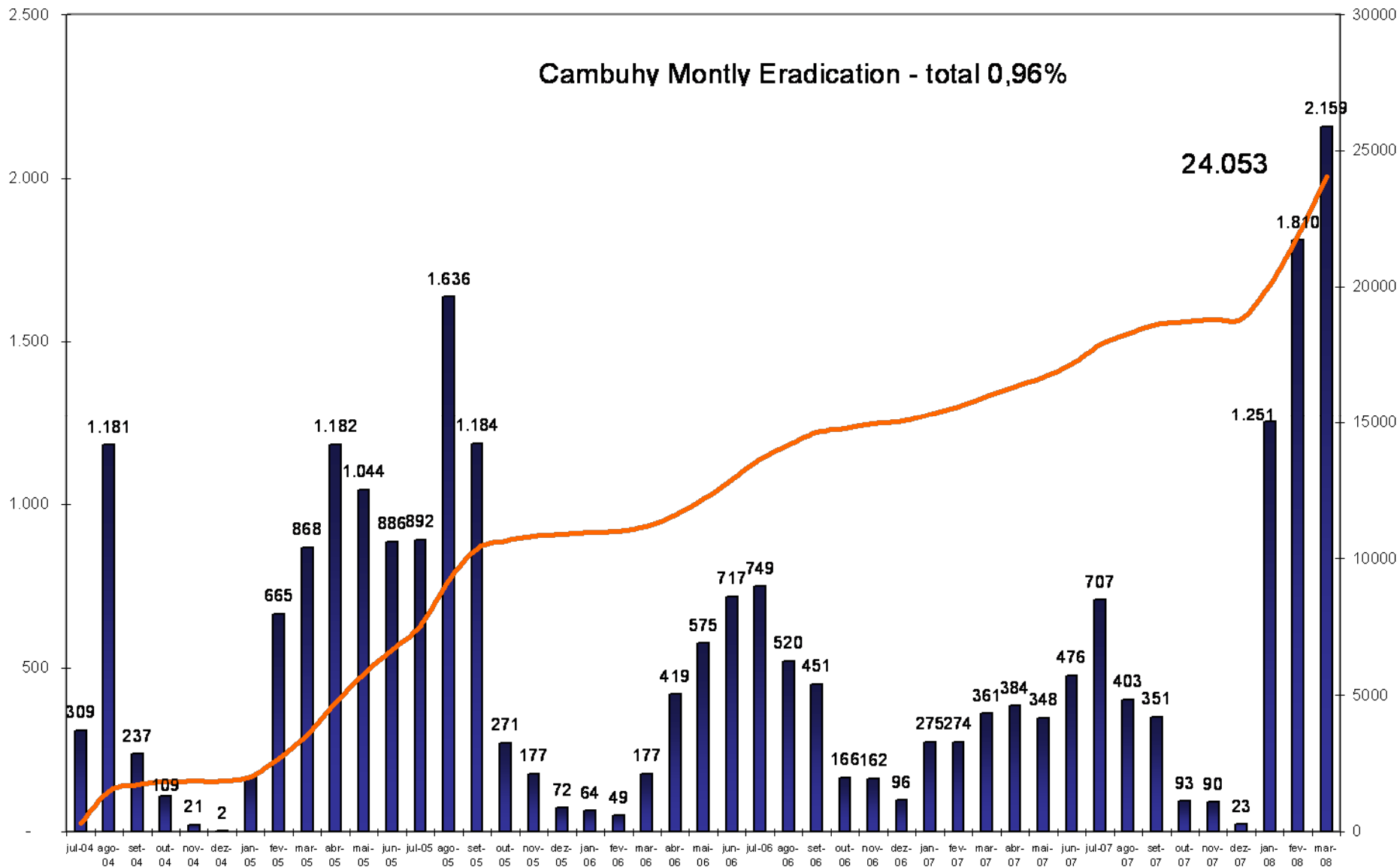
From July 2004 until December 2007



From July 2004 until April 2008

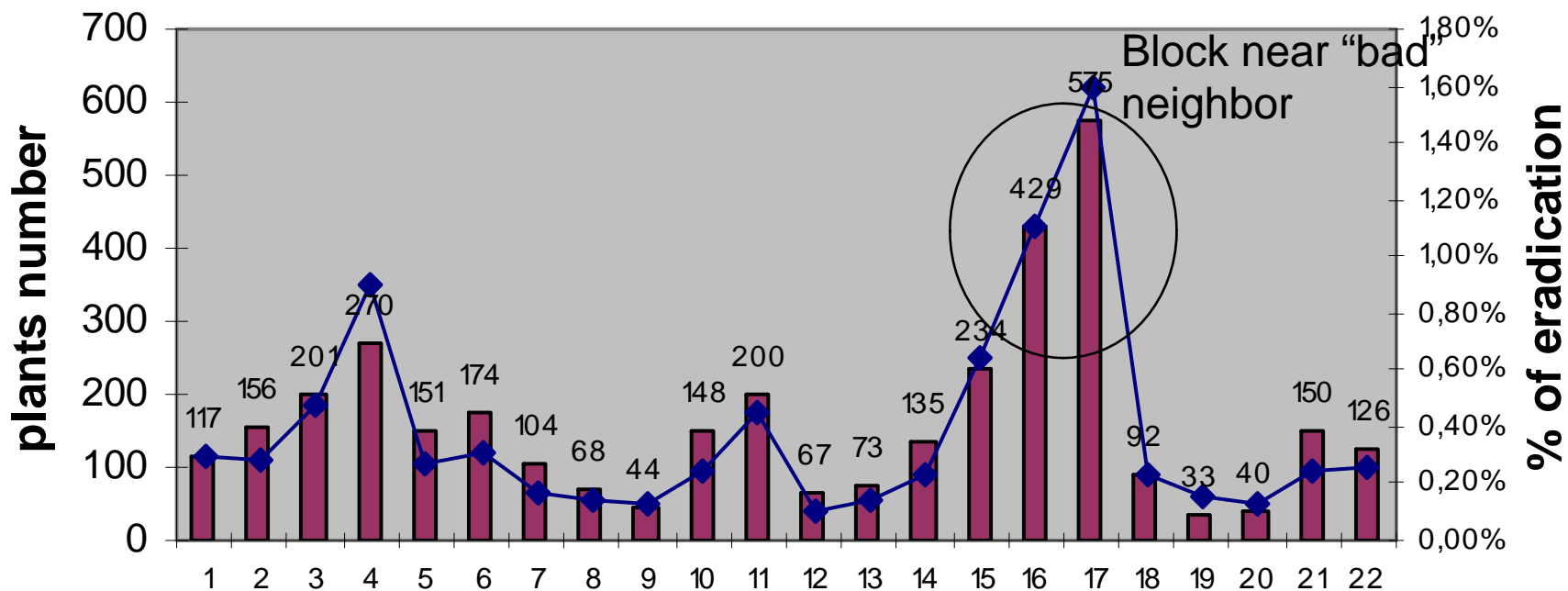


Cambuhy Montly Eradication - total 0,96%



Plant eradication every day in the last 4 years

Cambuhy - Number and % of eradication in the last 22 days



Citrus plant eradication

- To us it is easy to make citrus plant eradication.
- In our recent citriculture history, we remove plants because Blight or Citrus canker (low rates) or CVC.

Actual inspection Model

- 100% Platform
- 2 Platform type:



2.0 meter (6.4 feet)

Adult Plant Platform (4 people)



3.0 meter (9.6 feet)

Young Plant Platform (2 people)

Platform number/acre



Spring/Sumer = 1 platform/1800 acres

Winter/Fall = 1 platform/1500 ha

Goal = 4 inspections/year (minimum)

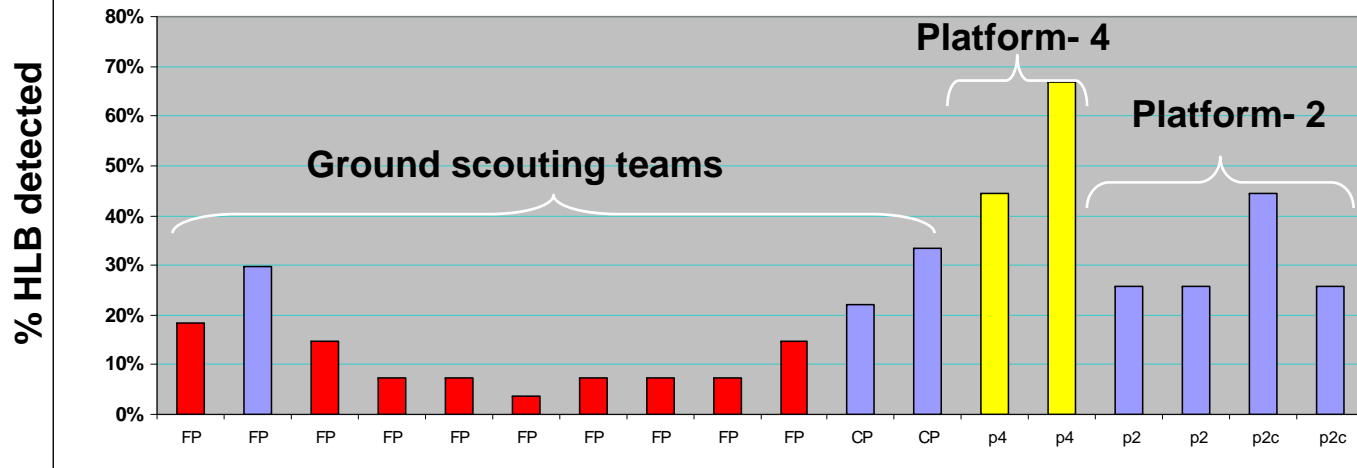


All year = 1 platform/1.200 acres

Goal = 12 inspections/year

Why we decided to change to platform

Efficiency of different scouting methods



A well-trained 4-platform scouting team could find up to 70% of symptomatic plants while the best ground team was able to find only 30%





+



**Training & Cross Inspection
& Bonus**

Machines



Inspection with quality

Inspection costs (5,000 plants/day)

It is necessary to have 1 platform/1,750 acres

Inspector = US \$ 3.82/hr x 4 x 8,8 =
134/5,000 pl. = **US \$ 0.03/pl**

Platform = US \$ 2,050/5 year = US\$
410/year = US \$ 2.05/day = **US\$ 0.0004/pl.**

Tractor driver = US \$ 4.10/hr x 1 x 8,8 =
US\$ 36/5,000 pl = **US\$ 0.007/pl.**

Used Tractor = US\$ 7.6/hr x 6 hr/day = US\$
45.88/5,000 pl = **US\$ 0.009/pl.**

Total cost = 5 cents/plant

4 times/year = 20 cents/plant

Today Price Box in Brazil +/- US\$ 6.00 =

+ 3.3 % costs/box



Scouting: Checking and motivating



Proper management of scouting team is very important. First cross checked by PCR for confirmation of visual diagnosis for increased confidence.

**A well thought motivational approach is required.
All inspectors receive motivational monthly bonus**

Eradication

4 Supervisors PCR trained
“eyes” = decide to eradicate
or not! **1 PCR test per 500
eradicated plants**

HLB plant
and
branch
marked

Insp.



10:25 A.M.



9:00 A.M.



8:16 A.M



8:15 A.M.

Steps

Correct Young Plant Eradication Model

Herbicide

Eradication



14:35 A.M.

**4 Supervisors PCR
trained "eyes" = decide to
eradicate or not!**



9:00 A.M.

**HLB plant,
row and
branch
marked**



10:45 A.M.

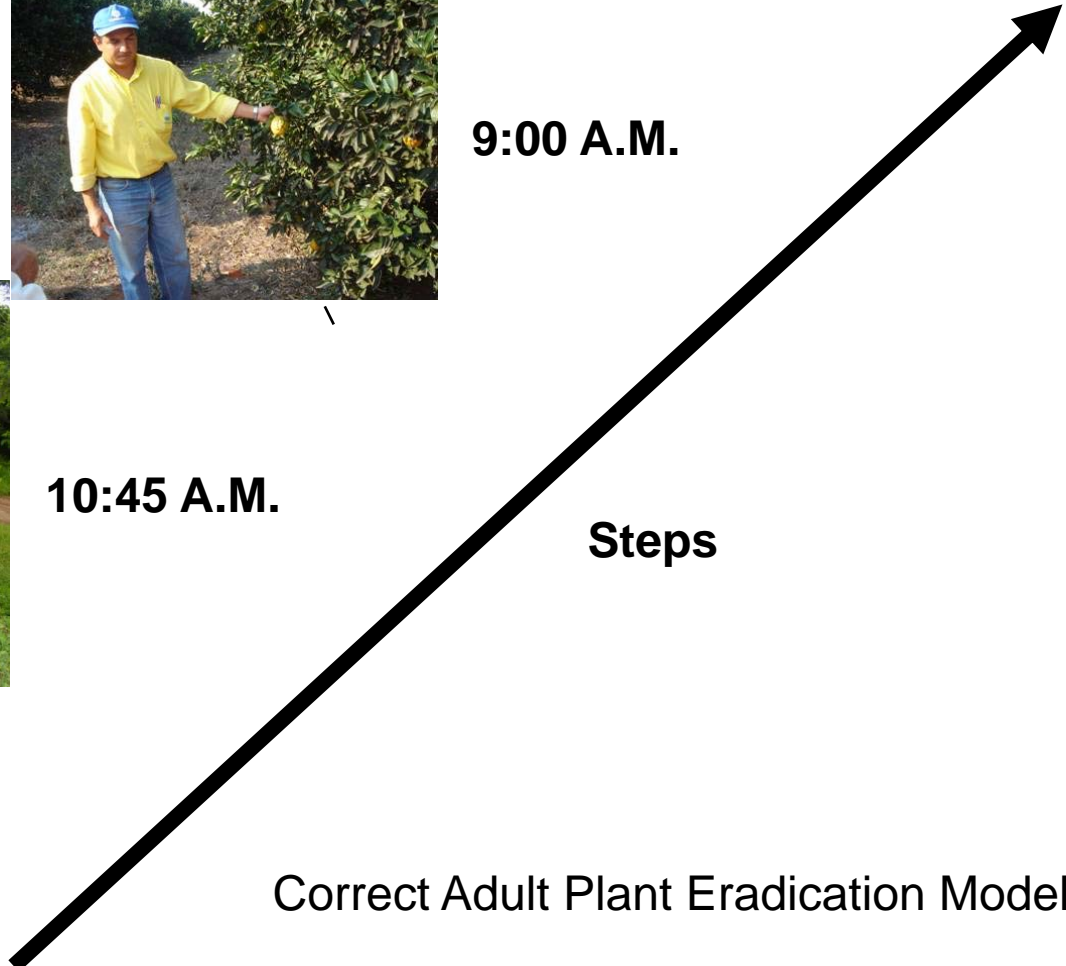
Insp.



8:00 A.M.

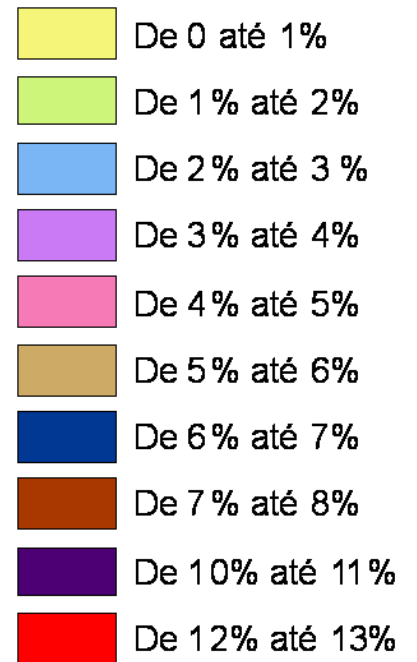
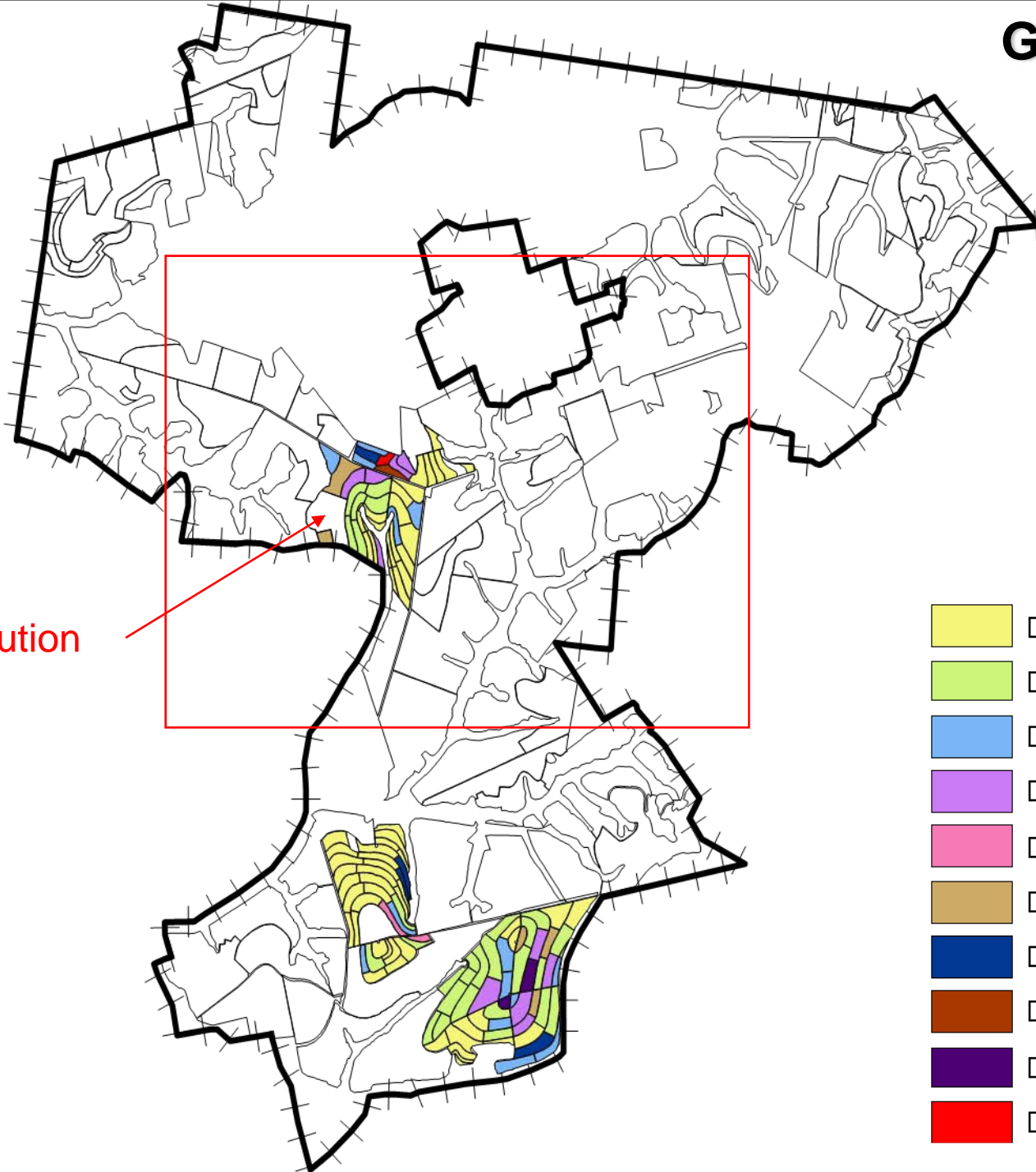
Steps

Correct Adult Plant Eradication Model



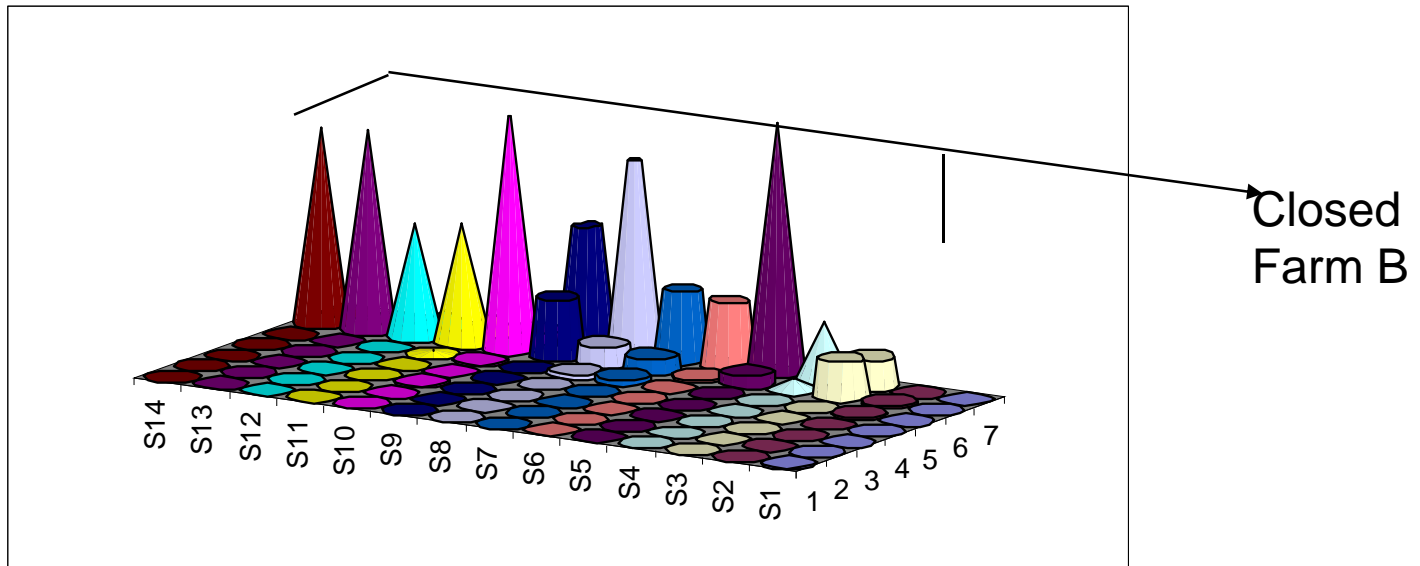
Greening

Erratic distribution



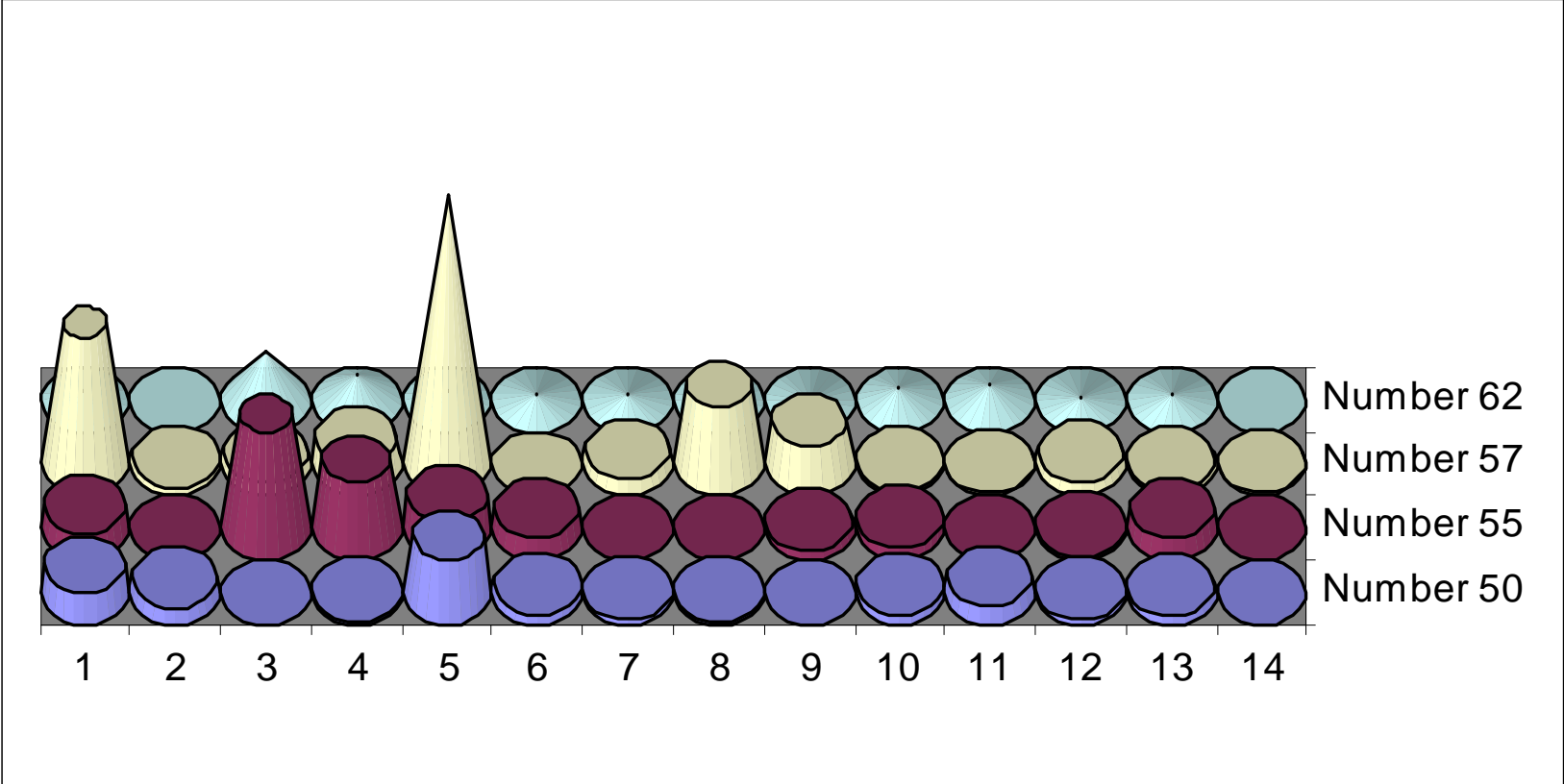
Inspection Number 2 Worst Young Block (Near Infected Farm B)

Block	1	2	3	4	5	6	7	Total
97 (4 yr)	0,03%	0,00%	0,00%	0,01%	0,00%	0,00%	0,00%	0,04%
97 A 2 yr (G13)	0,00%	0,00%	0,00%	0,00%	0,05%	0,11%	0,00%	0,16%
97A (G14)	0,00%	0,00%	0,00%	0,00%	0,00%	1,70%	1,34%	3,04%
97A (G15)	0,00%	0,00%	0,00%	0,00%	0,00%	0,54%	2,57%	3,11%
97A (G16)	0,00%	0,00%	0,00%	0,00%	0,00%	0,54%	10,98%	11,52%
97A (G17)	0,00%	0,00%	0,00%	0,00%	0,00%	0,07%	2,92%	2,99%
97A (G18)	0,00%	0,00%	0,00%	0,00%	0,26%	0,69%	3,11%	4,06%
97A (G19)	0,00%	0,00%	0,00%	0,00%	0,20%	0,92%	8,49%	9,61%
97A (G20)	0,00%	0,00%	0,00%	0,00%	0,00%	2,67%	5,34%	8,01%
97A (G21)	0,00%	0,00%	0,06%	0,00%	0,06%	10,31%	0,48%	10,91%
97A (G22)	0,00%	0,00%	0,00%	0,00%	0,20%	5,24%	0,88%	6,32%
97A (G23)	0,00%	0,00%	0,00%	0,00%	0,00%	4,95%	0,71%	5,66%
97A (G24)	0,00%	0,00%	0,00%	0,00%	0,00%	8,79%	0,31%	9,10%
97A (G25)	0,00%	0,00%	0,00%	0,00%	0,00%	8,65%	0,21%	8,86%



Inspection Pattern – 5 worst Adult blocks in Cambuhy Farm (center of the Cambuhy)

Block	Inspection Number														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Number 50	1%	0%	0%	0%	2%	0%	0%	0%	0%	0%	1%	0%	0%	0%	5%
Number 55	1%	0%	4%	2%	1%	1%	0%	0%	0%	0%	0%	0%	1%	0%	11%
Number 57	5%	0%	0%	1%	9%	0%	1%	3%	2%	0%	0%	0%	0%	0%	22%
Number 62	0%	0%	2%	1%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	5%



Cambuhy – HLB Eradication %/age

Age	% Eradication
0-1	0
1-2	0
2-3	0,53
3-4	0,16
4-5	0,44
5-6	0,83
7-8	3,05
> 8	0,91

Vector control is more difficult with young plants.
Many more flushes/year

0.43% (81% Border Block near infected neighbor)

First infection with 3 years old in 2004.

Difficult decision: removing the entire blocks



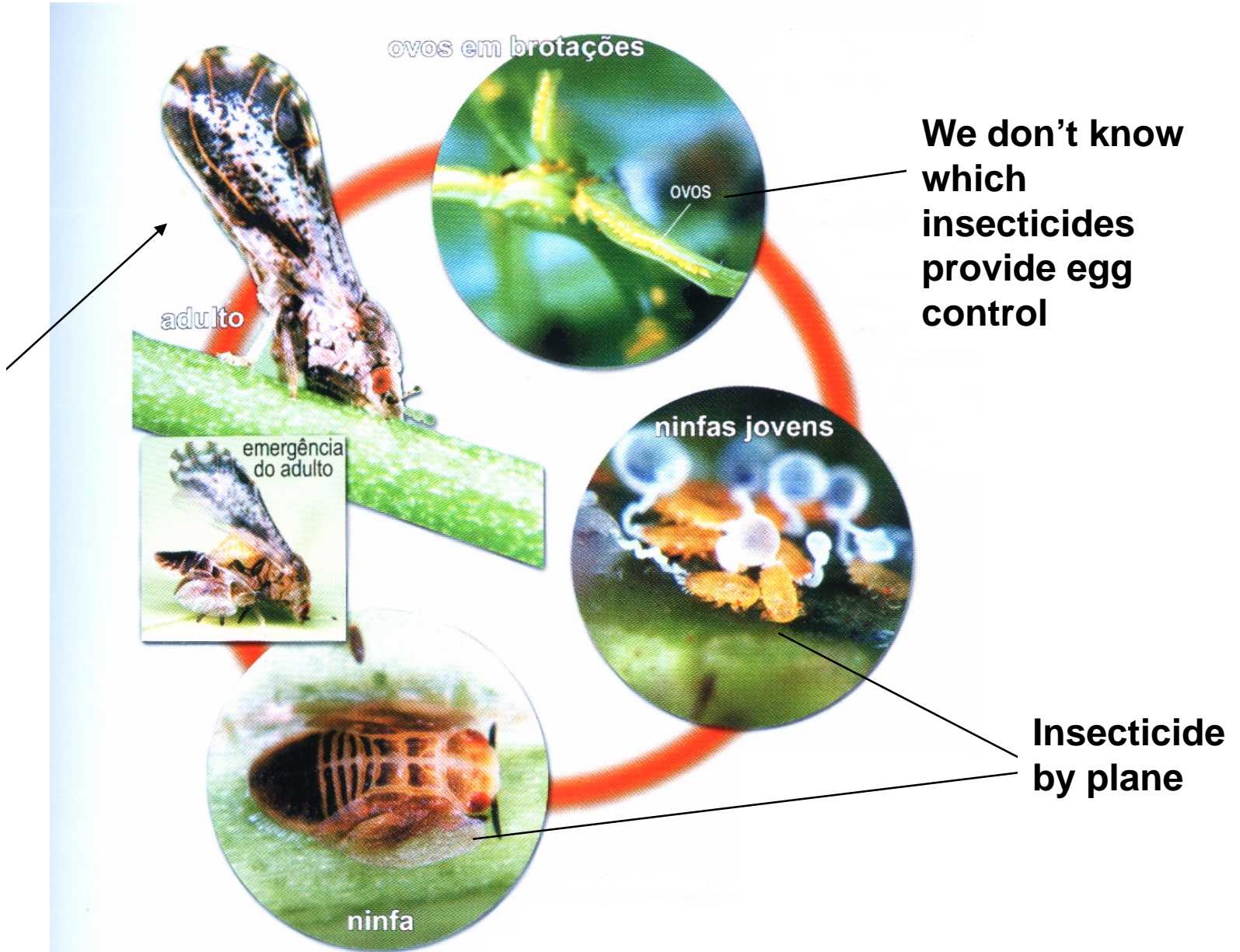
**Management strategy:
Blocks with more than 20% HLB in one inspection
are immediately removed**

Vector Control

Vector control

- Impossible to control 100%.
- The *Diaphorina citri* population is so high all time with difficult insecticide control.
- Higher population of nymphs and adults are observed during the spring and summer.
- Mainly insecticides without egg control.
- The Target = nymphs control.

Diaphorina life cycle



Vector control 2 difficulties scenarios

- Young plants (0-6 years)



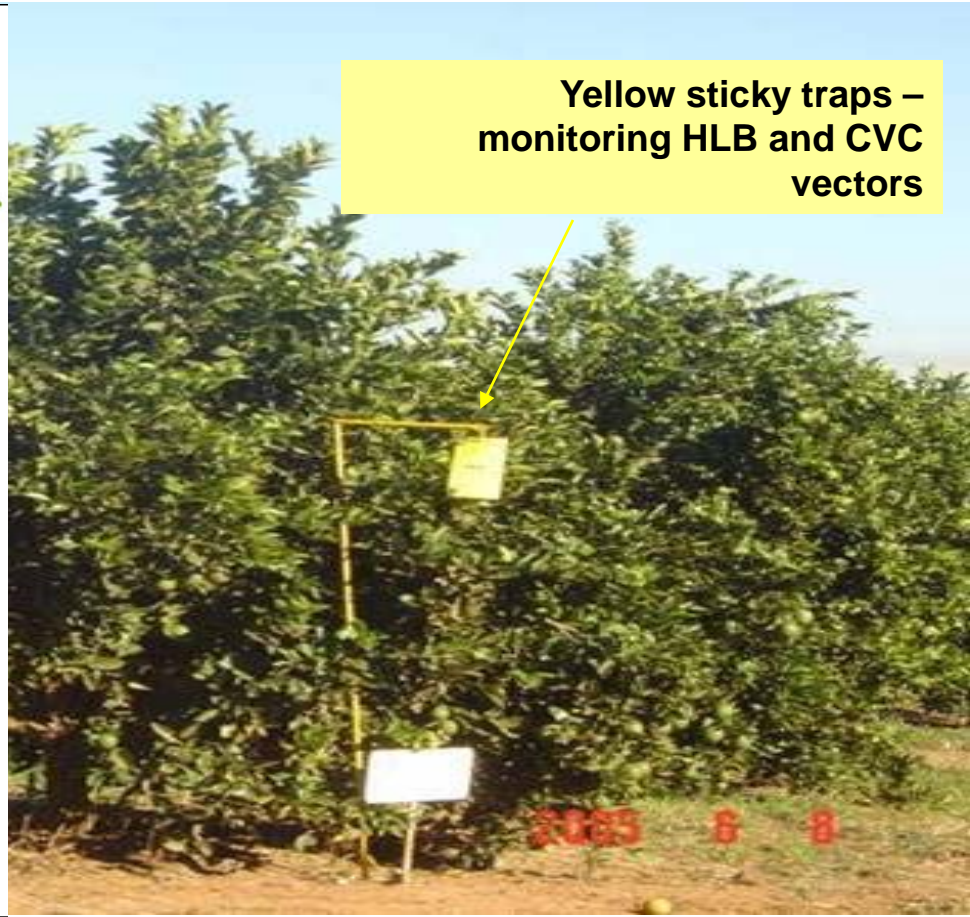
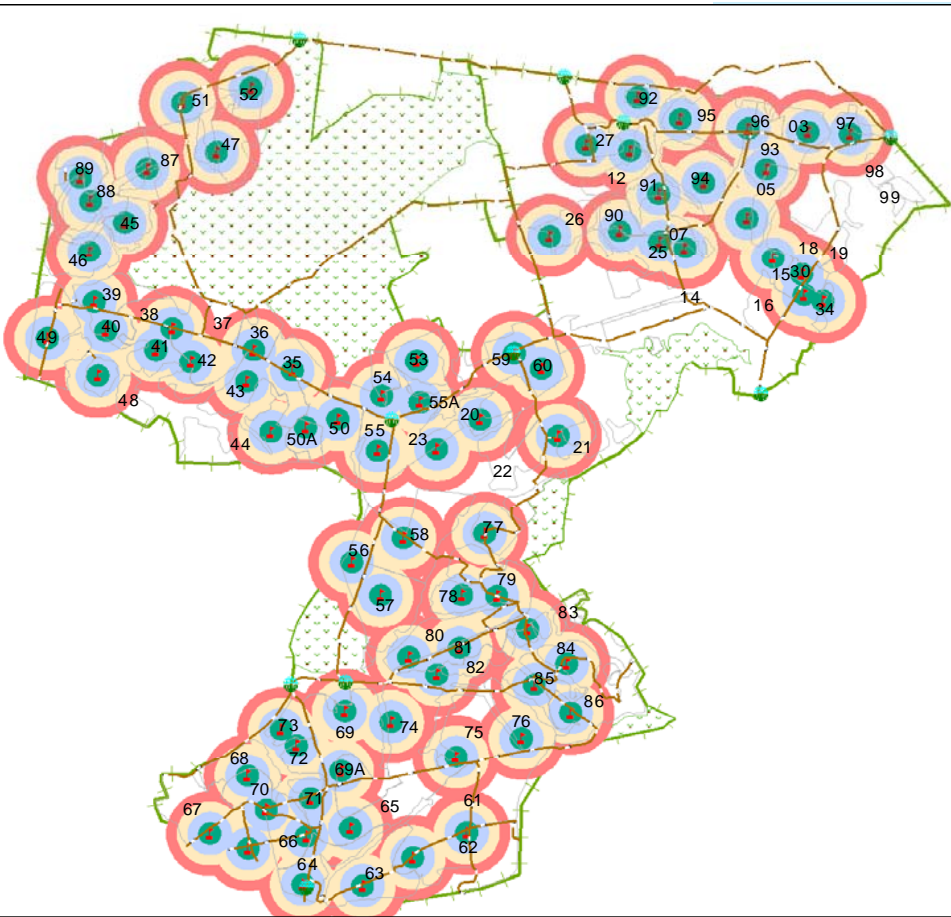
(4-6 foliar flushes/year)
> 10 flushes/year (under irrigation)

- Adult Plants (> 7 years)



Mainly 3-4 flushes/year

MONITORING PSYLLIDS

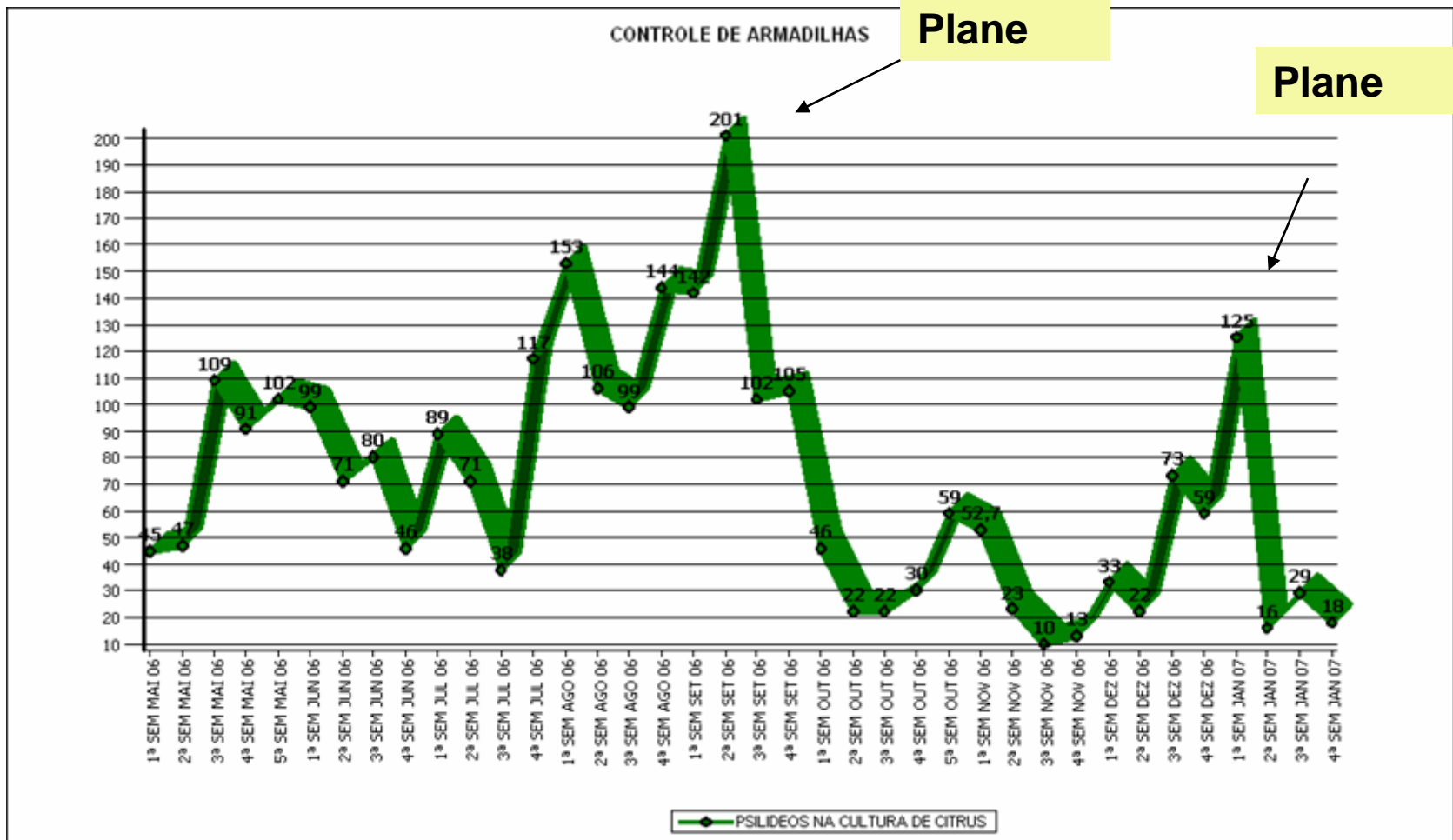


**Yellow sticky traps –
monitoring HLB and CVC
vectors**

100 yellow sticky traps are placed strategically in different citrus blocks in the farm

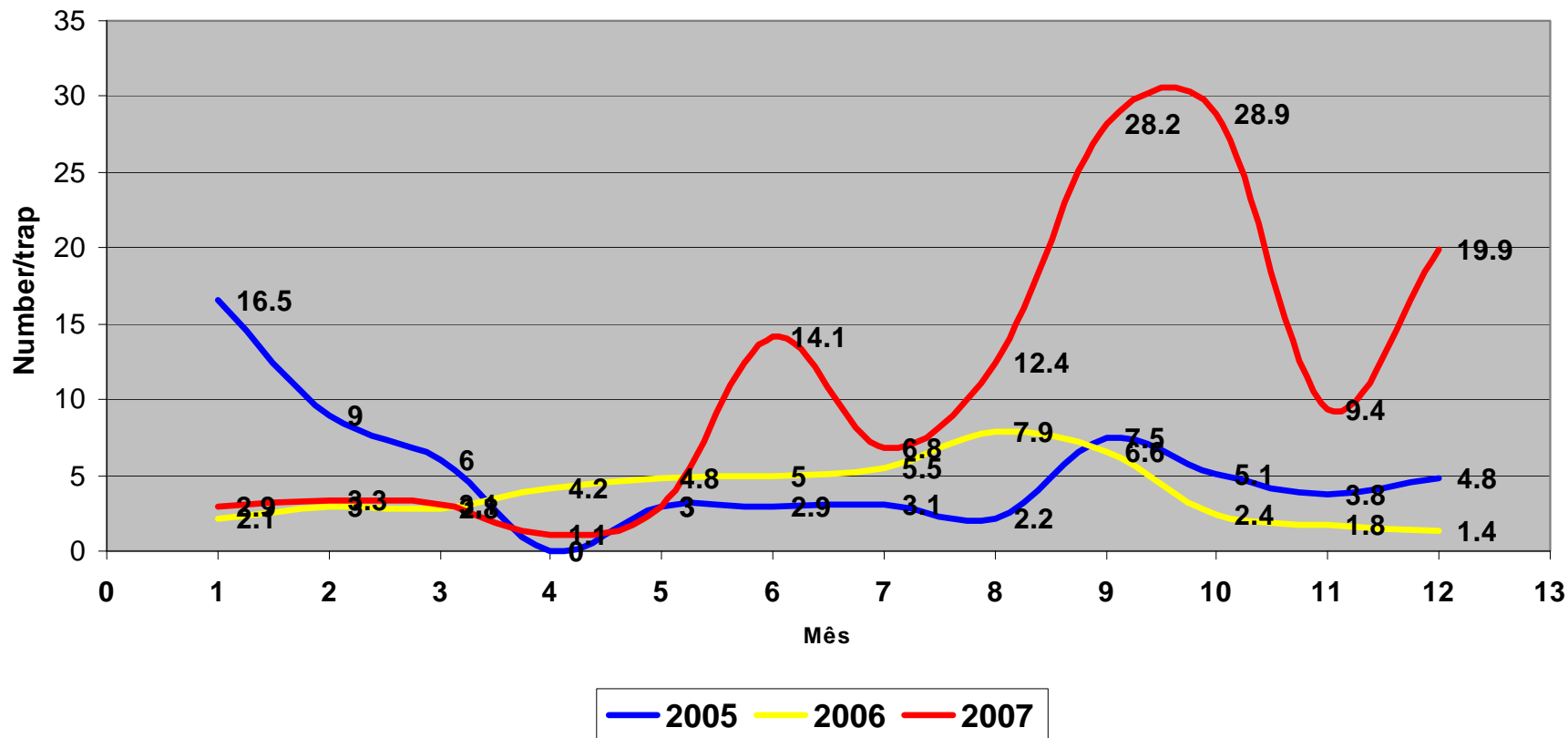
The traps are inspected every week, and the spray program will depend on the results of monitoring (spot spray versus aerial spray of the entire farm in two days)

MONITORING PSYLLIDS



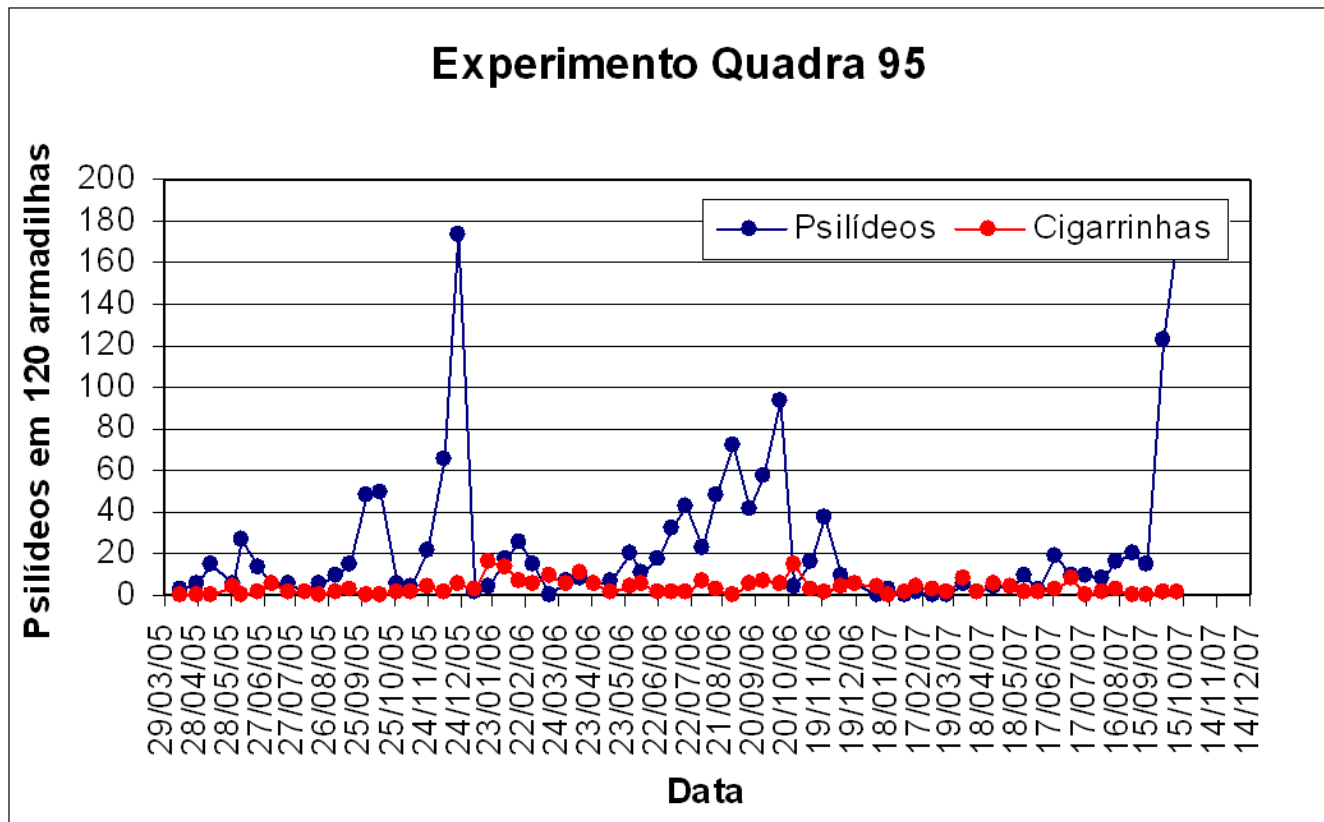
Weekly data on total psyllids from 100 yellow sticky traps

Yellow trap Diaphorina population 2005, 2006, 2007








Vector control

- Impossible control 100%.
- Very difficulty vector control comparative to CVC Vector



Cigarrinhas
= sharpshooter
Psilideos
= psyllid

Vector Control Summary

Age (years)	Spray Machine Type	Insecticide by foliar	Systemic Insect (drench)	Insecticide by plane
0-1		24 times/year	2	0
2-6		24 times/year	2	3
2-6 Near Infected Neighbor Block		24 times/year	4	3
> 6 < 3% HLB/year		Yellow trap Psylla Number (about 5 times/year)	0	3
>6 > 3% HLB/year		12 times/year	0	3

Vector Control Summary for Resets

Age (years)	Spray Machine Type	Insecticide by foliar	Systemic Insect (drench)	Insecticide by plane
All	Various	24 times/year	4	0



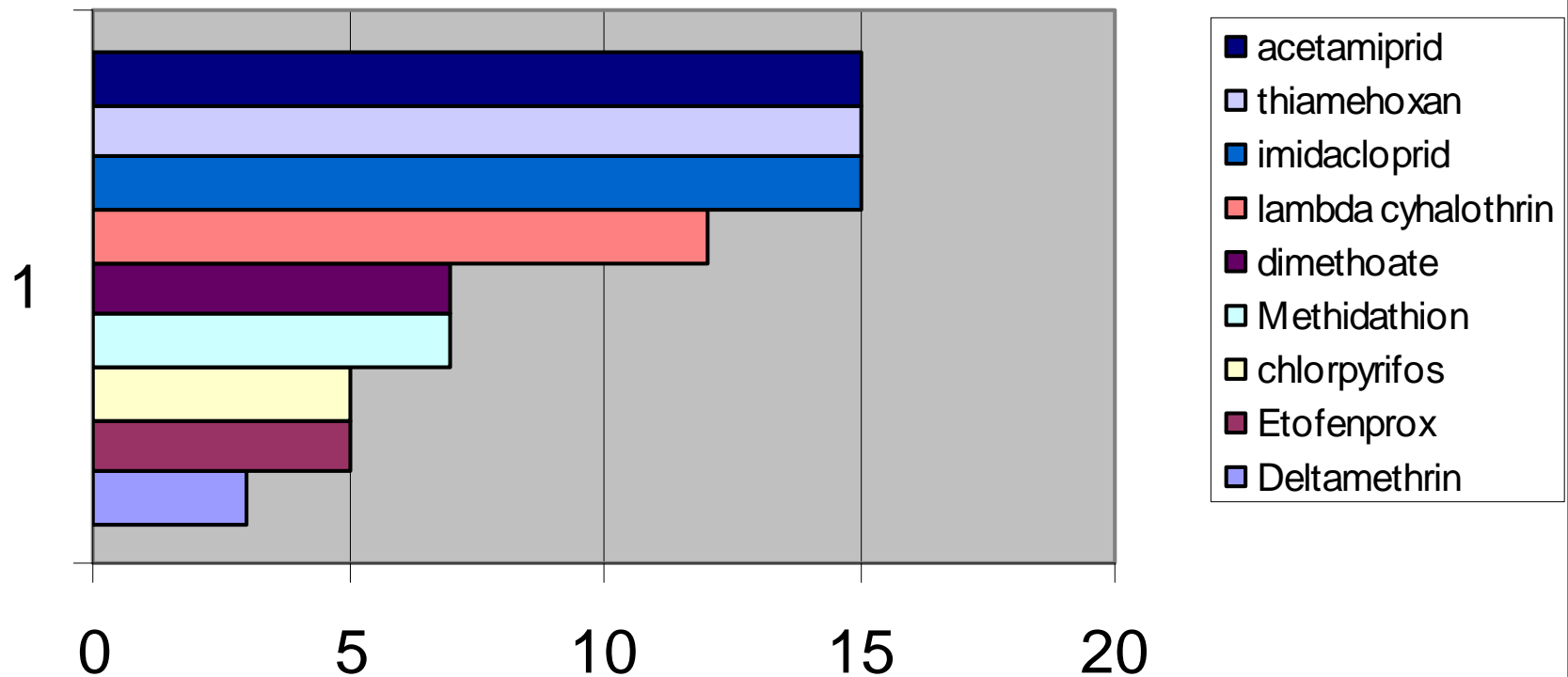
Adult Plants = 4 flushes/year

Resets = 8 flushes/year

Why do we spray every 15 days to young plants?

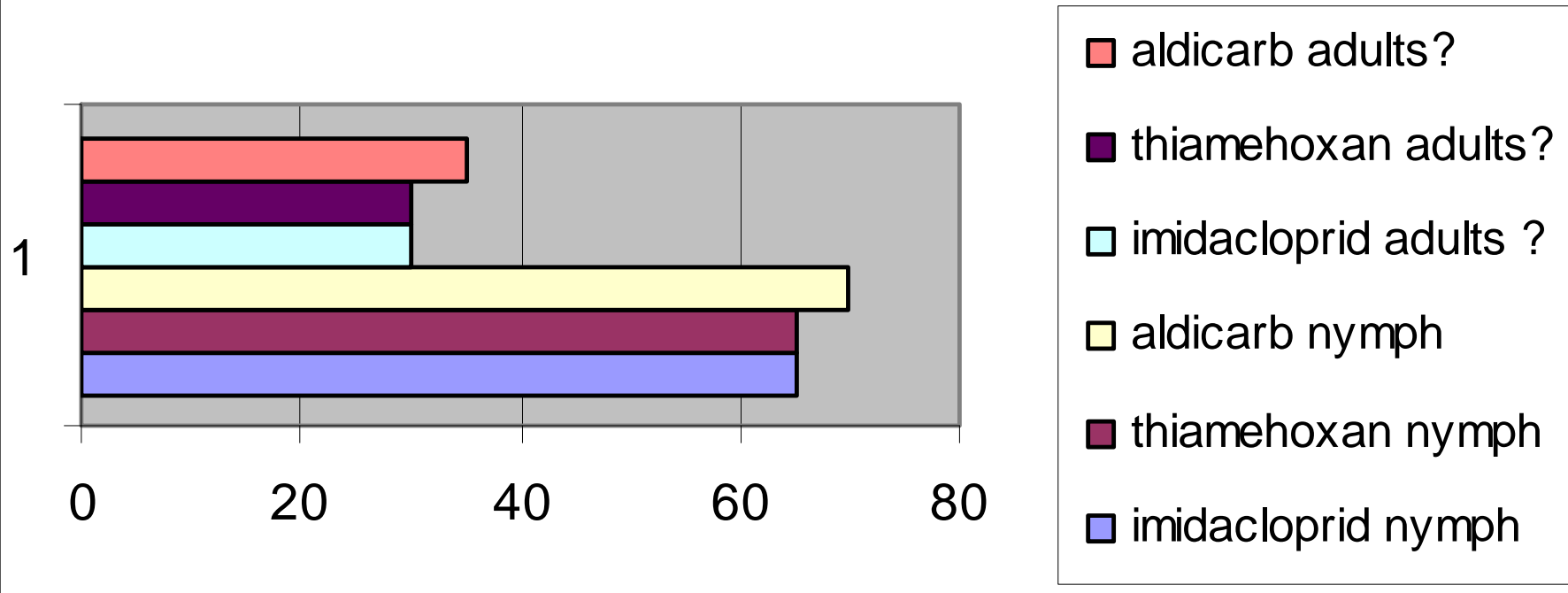
Diaphorina control time of foliar insecticides

Insecticide control days (practical observation)



Diaphorina control time of systemic insecticides

Insecticide control days (practical observation)



Insecticide by plane – foliar flushes – leaf with 2 centimeters (less than 1 inch



Mineral Oil = 2
liters/acre

Provado = 120
ml/acre

Abamectin = 60
ml/acre

Blocks less than 4 years

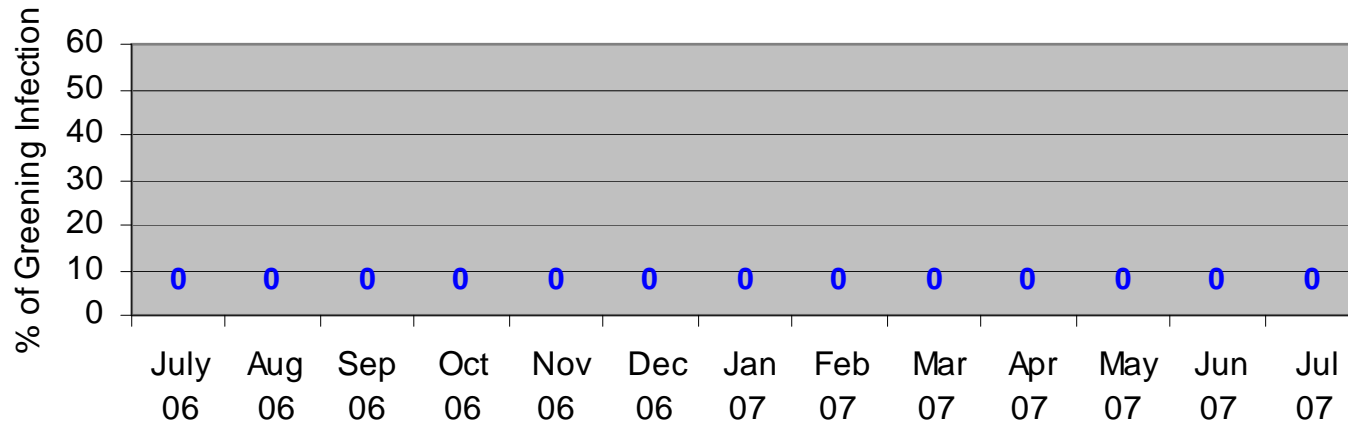
- 24 insecticides applications/year.
- 2 systemic insecticides/year
- 12 regular insecticides/year
- 12 microbiological (fungal) insecticide + 12 regular insecticides/year



Problems caused by high frequency sprays

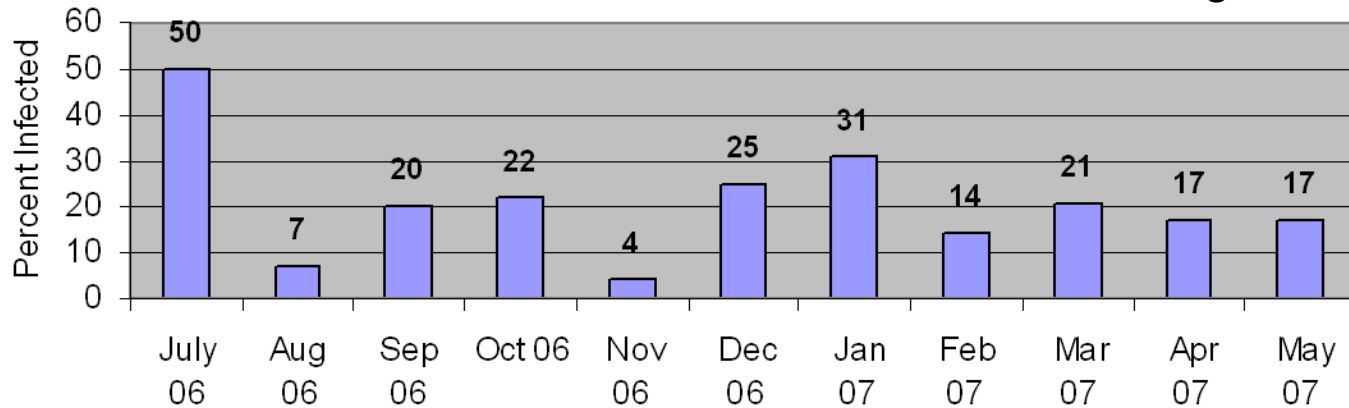
- **Secondary mites become out of control**
- **Increase in scale insects**
- **Continuing restrictions imposed by juice buyers on different Insecticides**
- **Difficulties in managing safe harvests (time between spray and harvest)**
- **Development of resistance against new insecticides**
- **Specific characteristics of each insecticide effectiveness**

Cambuhy Adult Psylla Real Time PCR



Adult Psylla Real Time PCR analysis

Cambuhy Neighbor

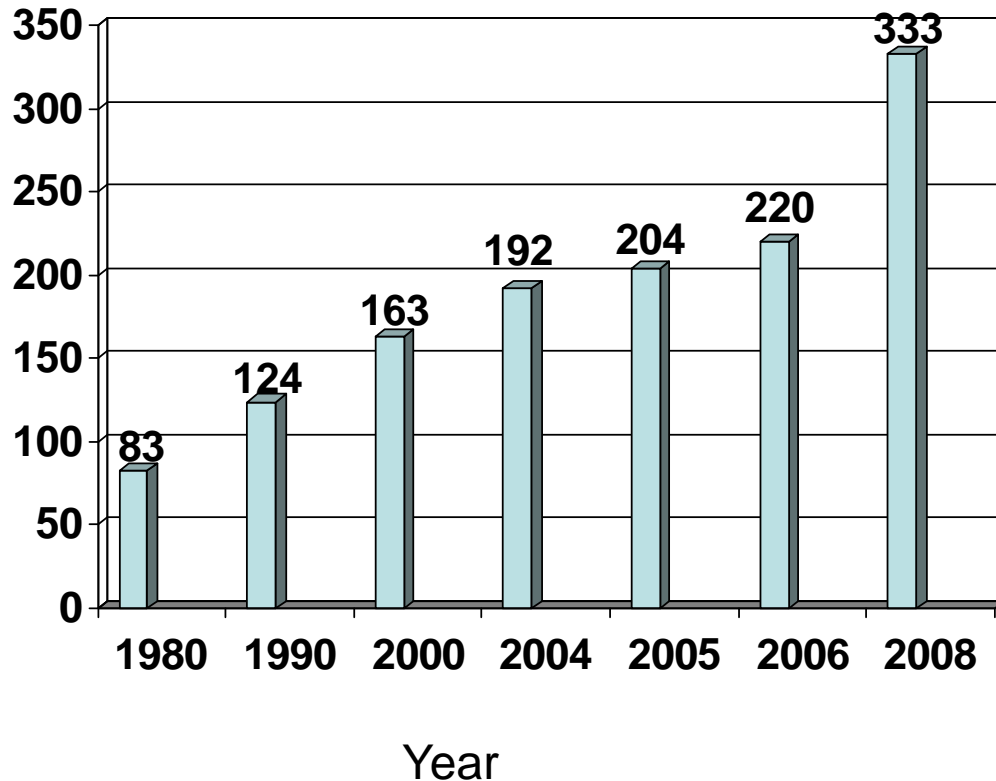


Weekly PCR Test are made in USDA California by Drs. Manjunath and Lee.

Others cultural important (crop) points

- Increase the plant density/area
- Increase the micronutrient levels
- Mechanical prune
- Resets = additional risk = much more flushes than adult plants.

Increase the plant density/area



Val. Americana

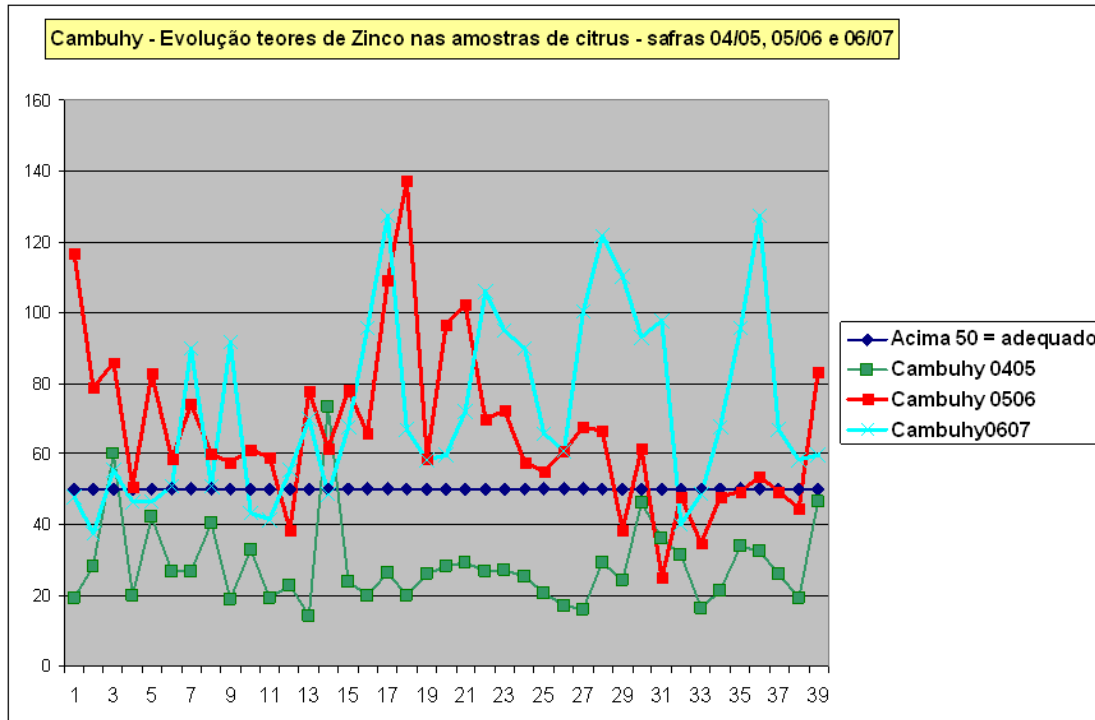
Planted August 2005

6 x 2.5 m (266 pl/acre)

2.5 years

8.0 ton/acre

Increase the Zinc, Manganese and Iron foliar level is important in Florida



Cambuhy leaf level goal:

Zn and Mn = 80 ppm

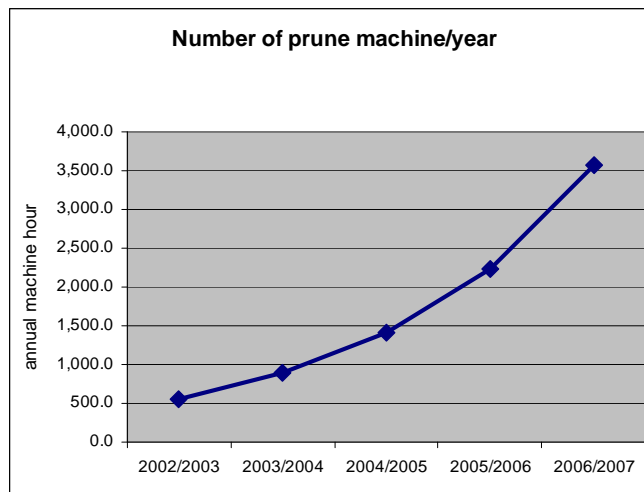
Mechanical Prune (remember *one more flush one more insecticide application*)



Easy to inspection.

Easy to spray insecticides by machines.

Easy to psylla control by plane



Sixteen things “not to do”

Based on our own mistakes and observations in several farms that have been either wiped out or severely affected

- 1. Refusing to accept the presence of HLB**
- 2. Delaying the beginning of inspection**
- 3. Scouting by people not trained specifically for HLB**
- 4. Scouting the field at low frequency (e.g., once or twice a year)**
- 5. Scouting by walking in blocks with mature trees**
- 6. Skipping scouting in parts of blocks with difficult access**
- 7. Managing HLB by vector control only (without eradication)**
- 8. Spraying at low frequency in younger trees (under 5 years)**
- 9. Fogging insecticides for vector control
(doesn't control the main target: nymphs)**

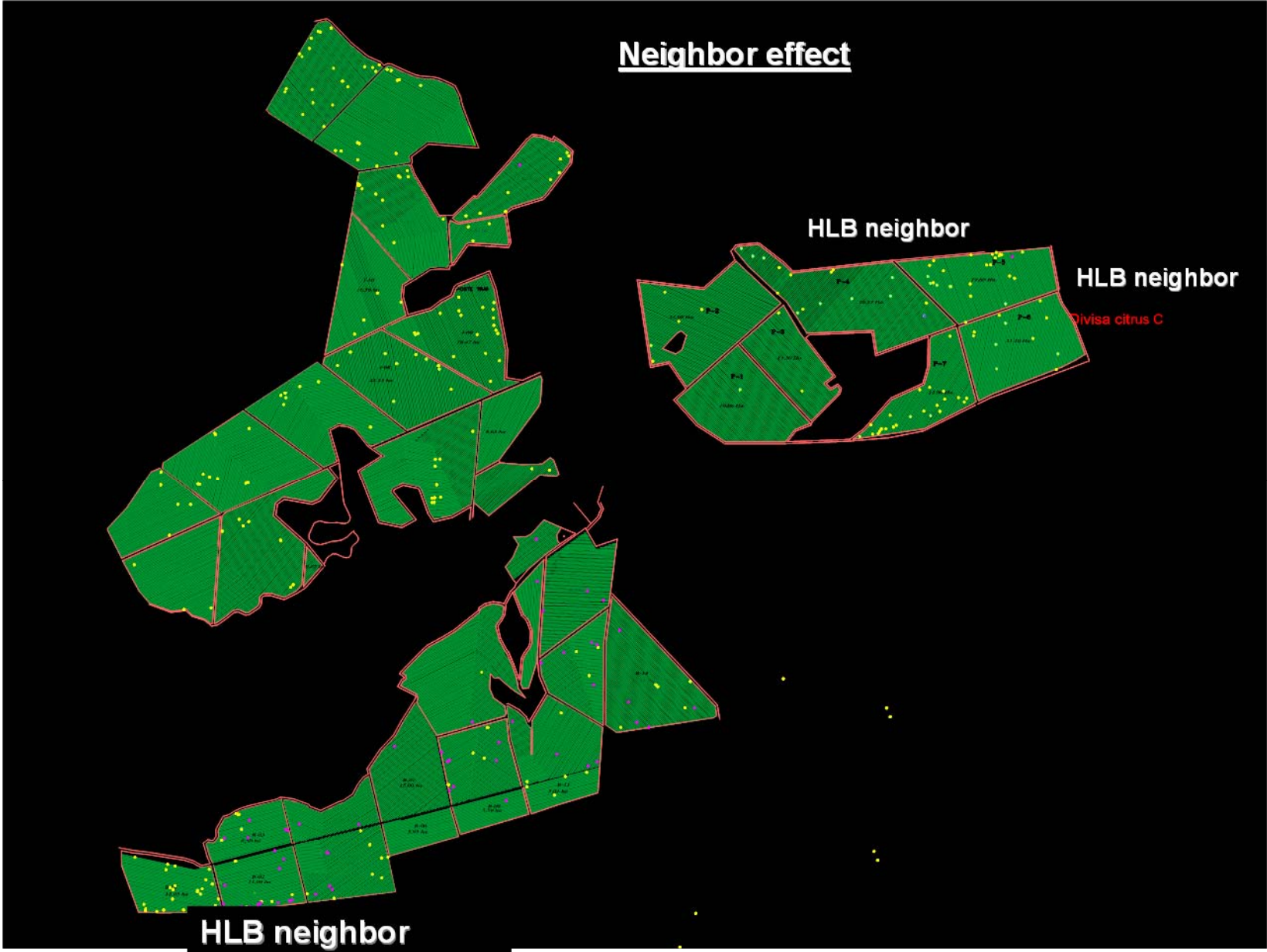
Sixteen things “not to do” (contd..)

Based on observation in several farms that have been either wiped out or severely affected

10. **Delaying the eradication after detection of HLB symptoms (let's get at least the crop on the tree)**
11. **Eradicating by using front end loader (leads to root sprouts of infected tree)**
12. **Eradicating symptomatic trees only, in blocks with more than 20% symptoms**
13. **Managing the disease by pruning of infected branches**
14. **Planting new orchard close to infected blocks**
15. **Using nursery plants produced in open field**
16. **Retaining ornamental plants like Murraya and other specialty citrus varieties**

Farm 5 - Agrindus

Farm 5 – Agrindus – Orchard with 4 years old – Bad Neighbor effects.



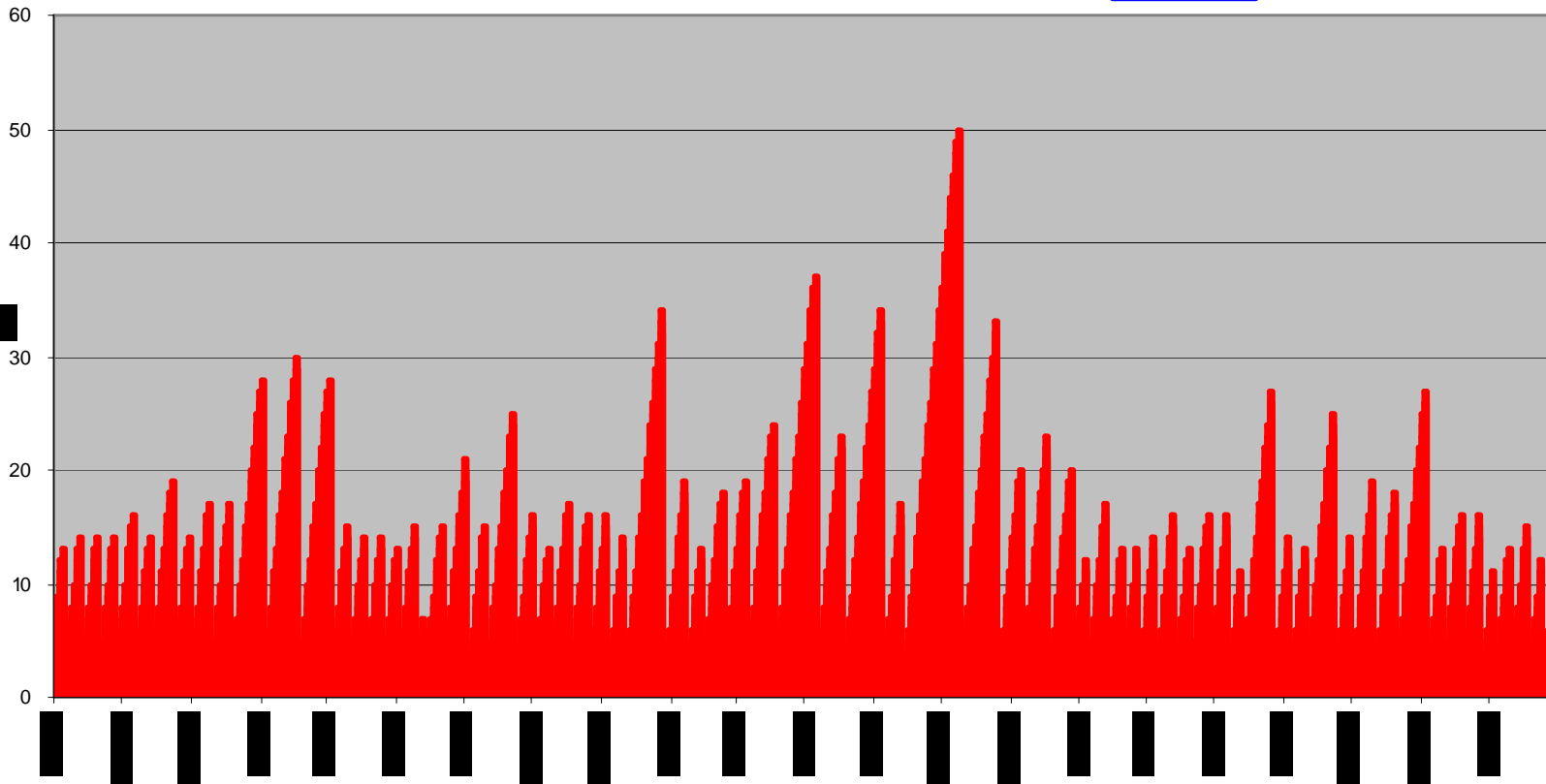
Agrindus Greening Management

- Vector control = 24 times/year = foliar insecticide.
- Inspection = 12 times/year = with 2 people platform.
- Project with 100% drip irrigation = reset all time.

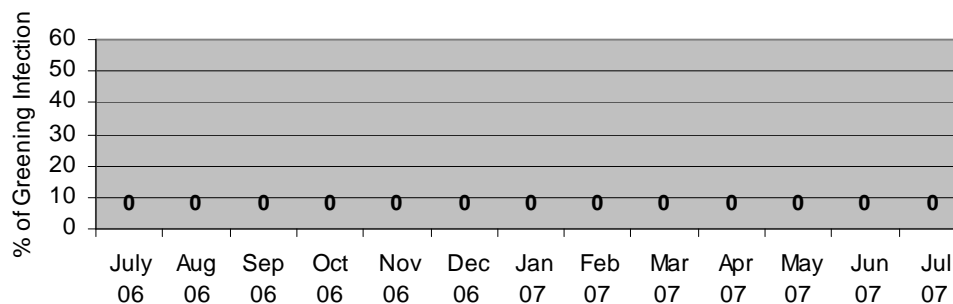
Agrindus Vector Control Frequency

Período entre aplicações de inseticidas - talhão:

■ B - 14

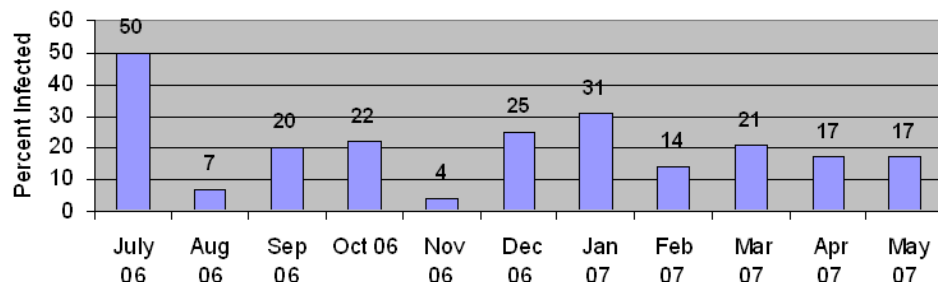


Cambuhy Adult Psylla Real Time PCR

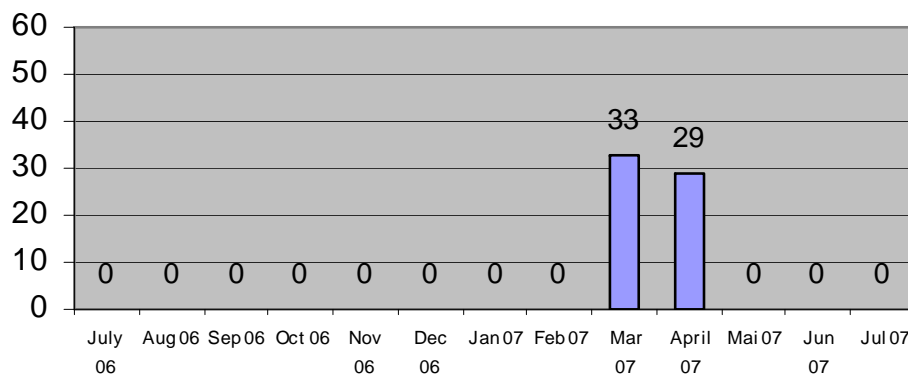


Cambuhy

Adult Psylla Real Time PCR analisis



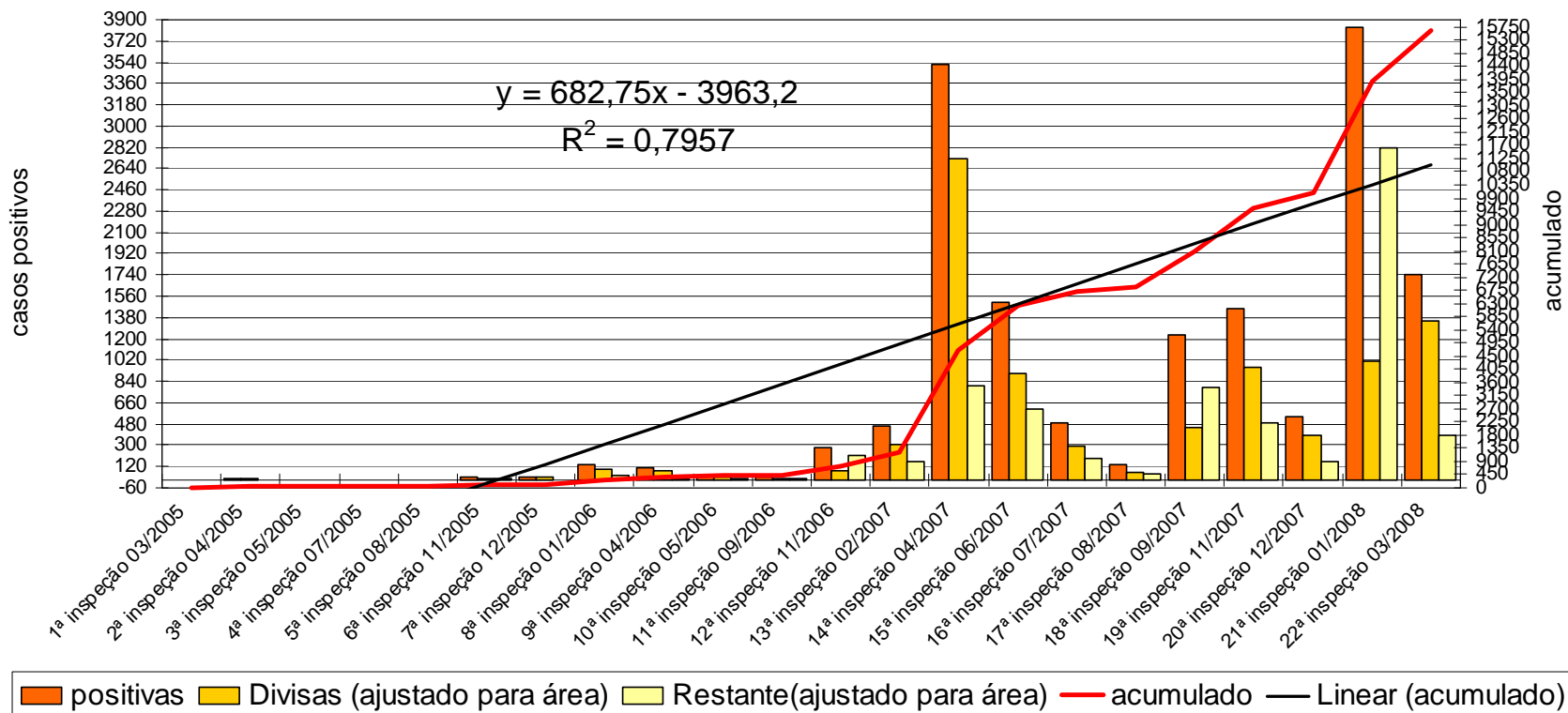
Cambuhy Neighbor



Agrindus – samples collected in the border with infected citrus orchard neighbor

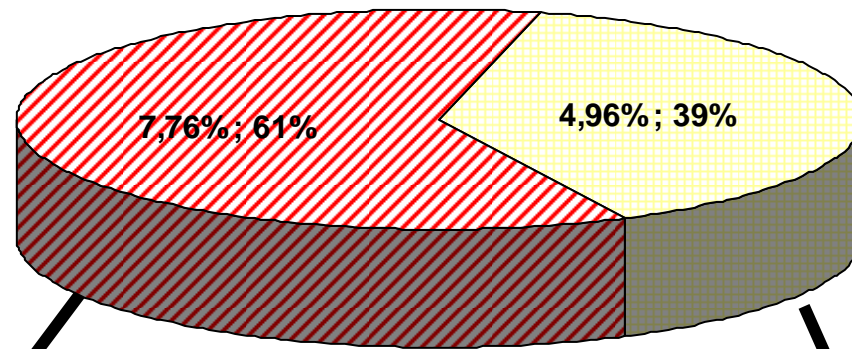
All Weekly PCR Test are made in USDA California by Drs. Manjunath and Lee.

Inspection progression



Neighbor effects in Farm A

Positive samples distribution
(removed plants/total block)



■ Divisas ■ Restante

Plants eliminated in borders

Plants with HLB eliminated inside the orchard

Conclusions

In summary, to have a low plants eradication rates it is necessary to do the following for managing Greening:

- ***production of healthy plants in screened nursery,***
- ***disease scouting with well trained and motivated staff,***
- ***vector monitoring***
- ***strong vector control***
- ***inspection and fast eradication of symptomatic trees***
- ***infected plant eradication and vector control with the neighbors, considerate a joint action against Diaphorina (by plane/spray/systemic insecticide) and fast infected plant eradication is the only method for success.***

Cambuhy HLB team and acknowledgments



Cambuhy Team: Jose Luiz A. Rodrigues (CEO); Paulo Henrique Sperandio (Vector Control Supervisor), Ludevino Pereira (HLB Supervisor), 52 Inspectors.
Dr. Bové;
Juliano Ayres and Fundecitrus Team.

