

WHY IS INOCULUM REDUCTION ESSENTIAL FOR CONTROLLING HLB?



RENATO B. BASSANEZI
renato.bassanezi@fundecitrus.com.br

ABSENCE OF EFFECTIVE THERAPY FOR HLB-AFFECTED TREES

No therapy has been proved to cure diseased trees or keep the yield and quality of fruit from this trees like that of healthy trees

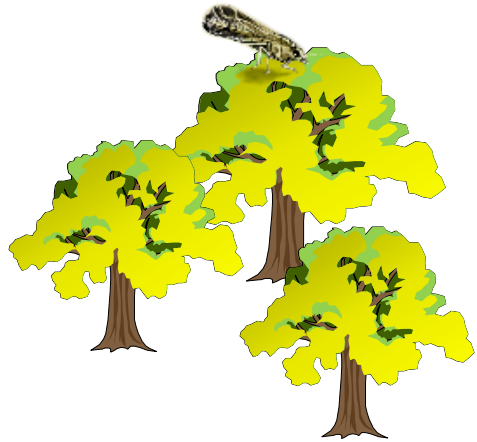
- » Pruning
- » Thermotherapy
- » Enhanced nutrition
- » SAR inducers
- » Antimicrobial peptides
- » Antibiotics
- » Plant growth



PREVENTION OF INFECTIONS

TWO PROCESSES OF DISPERSAL AND INFECTION OCCURRING CONTINUOUSLY AND SIMULTANEOUSLY

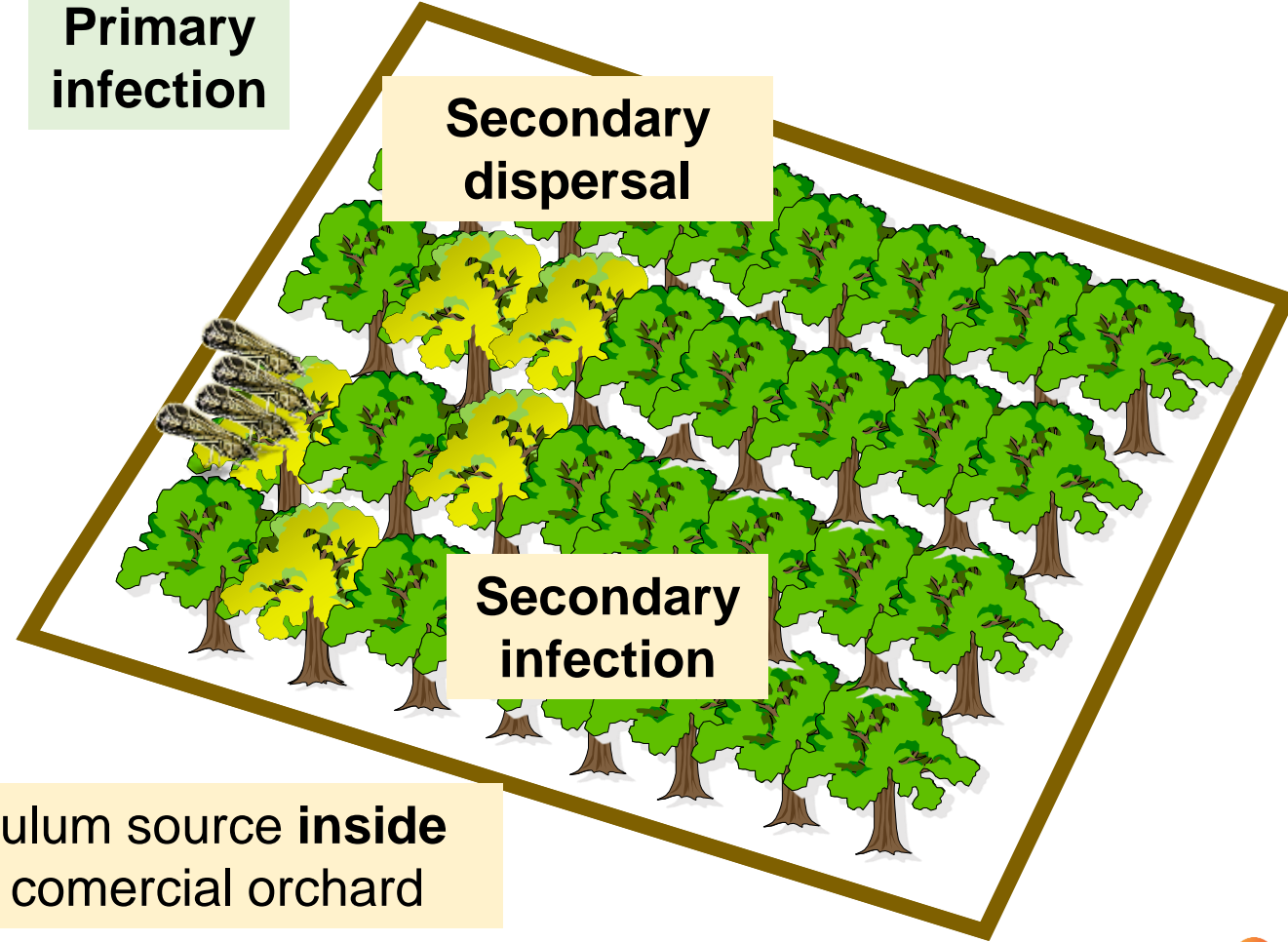
Primary dispersal



Inoculum source **outside** the comercial orchard

Diseased tres without psyllid control

Primary infection



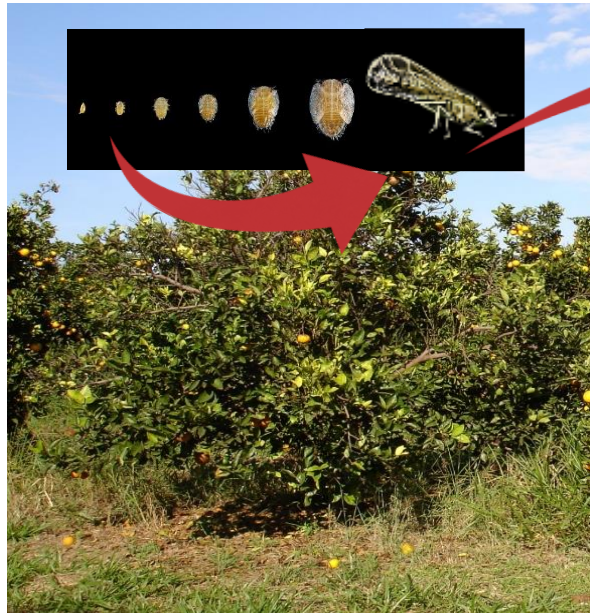
Secondary dispersal

Secondary infection

Inoculum source **inside** the comercial orchard

INFECTIONS FROM OUTSIDE INOCULUM SOURCE (Primary infection)

Outside the orchard



Acquisition by the nymph
High efficiency (~100%)

Latent period of bacteria in the vector is completed during nymphal stages

Inside the orchard



Transmission by the adult
<1h feeding
High efficiency (8-93%)

INFECTIONS FROM INSIDE INOCULUM SOURCE (Secondary)



Acquisition by the adult
>1 h feeding
Low efficiency (~30%)

Transmission by the adult
<1h feeding
Low efficiency (<5%)

Latent period of bacteria in the vector is completed in the adult (9 to 17 days)



Acquisition by the nymph
High efficiency (~100%)

Transmission by the adult
<1h feeding
High efficiency (8-93%)

Latent period of bacteria in the vector is completed during nymphal stages

Egg to adult cycle
12 to 19 days

PREVENTIVE CONTROL OF HLB INFECTIONS



Planting healthy nursery trees



Elimination of diseased trees inside and outside the orchards



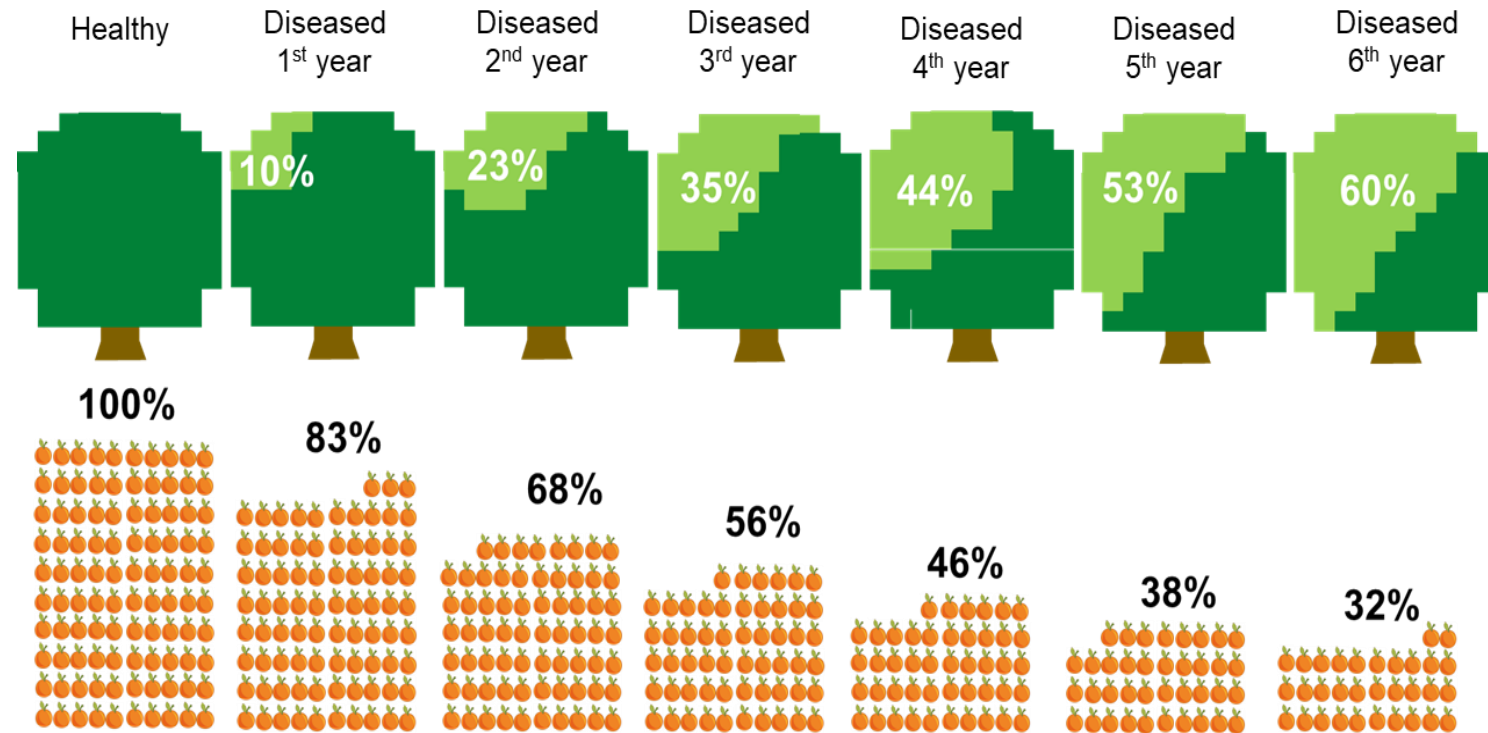
Control of psyllid vector inside and outside the orchards

REMOVAL OF HLB-AFFECTED TREES DILEMMA

» No grower likes to eliminate his diseased trees



Disease severity and yield progression in adult sweet orange trees



Bassanezi Citricos de las Americas 2018

REMOVAL OF HLB-AFFECTED TREES DILEMMA

»» Impact of removal diseased trees

»» Short term

Yield loss from affected trees
Reduced tree stand

»» Long term

Keep the fruit/juice quality
Allow new plantings



REMOVAL OF HLB-AFFECTED TREES DILEMMA

» Little effect of removing HLB-affected trees ONLY in commercial orchards

Effect of the frequencies of symptomatic trees removal applied in individual citrus blocks (local scale) on the Huanglongbing annual progress rates.

Frequency of local inoculum reduction	Annual progress rate of HLB-symptomatic trees incidence (\pm standard error) ^a							
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8
Fortnightly			2.34 \pm 0.08 ab				2.36 \pm 0.20 ^{n.s.}	3.09 \pm 0.22 ^{n.s.}
Monthly	1.05 \pm 0.11 b	1.00 \pm 0.07 ^{n.s.}	1.89 \pm 0.15 b	0.86 \pm 0.15 ^{n.s.}	0.97 \pm 0.06 ^{n.s.}	1.16 \pm 0.19 ^{n.s.}	2.77 \pm 0.20 ^{n.s.}	2.73 \pm 0.45 ^{n.s.}
2-months	1.42 \pm 0.16 ab	1.28 \pm 0.13 ^{n.s.}	2.52 \pm 0.13 a	0.91 \pm 0.05 ^{n.s.}	0.84 \pm 0.14 ^{n.s.}	1.02 \pm 0.10 ^{n.s.}		
3-months			2.48 \pm 0.11 a				2.30 \pm 0.13 ^{n.s.}	2.70 \pm 0.40 ^{n.s.}
4-months	1.28 \pm 0.04 b	1.01 \pm 0.16 ^{n.s.}		0.82 \pm 0.06 ^{n.s.}	1.13 \pm 0.08 ^{n.s.}	1.09 \pm 0.11 ^{n.s.}		
6-months	1.86 \pm 0.01 a						2.71 \pm 0.19 ^{n.s.}	2.71 \pm 0.07 ^{n.s.}
<i>P-value</i>	0.008	0.245	0.007	0.807	0.194	0.810	0.239	0.790

^{n.s.}Treatments in the column were not significantly different by Tukey HSD test ($P > 0.01$).

^a Logistic annual rates of disease increase (r_L) calculated by linear regression of transformed disease incidence over time.



Bassanezi et al. Crop Protection 2013

REMOVAL OF HLB-AFFECTED TREES DILEMMA

Little effect of removing HLB-affected trees ONLY in commercial orchards

Partial effect on “Secondary infections”

» Impossibility of finding and removing all infected trees from the orchard

- » Escapes in the inspection
- » Irregular distribution of bacteria inside the tree

» Asymptomatic trees can serve as source of inoculum before be detected

- » Short latency period and long incubation period

No effect on “Primary infections”

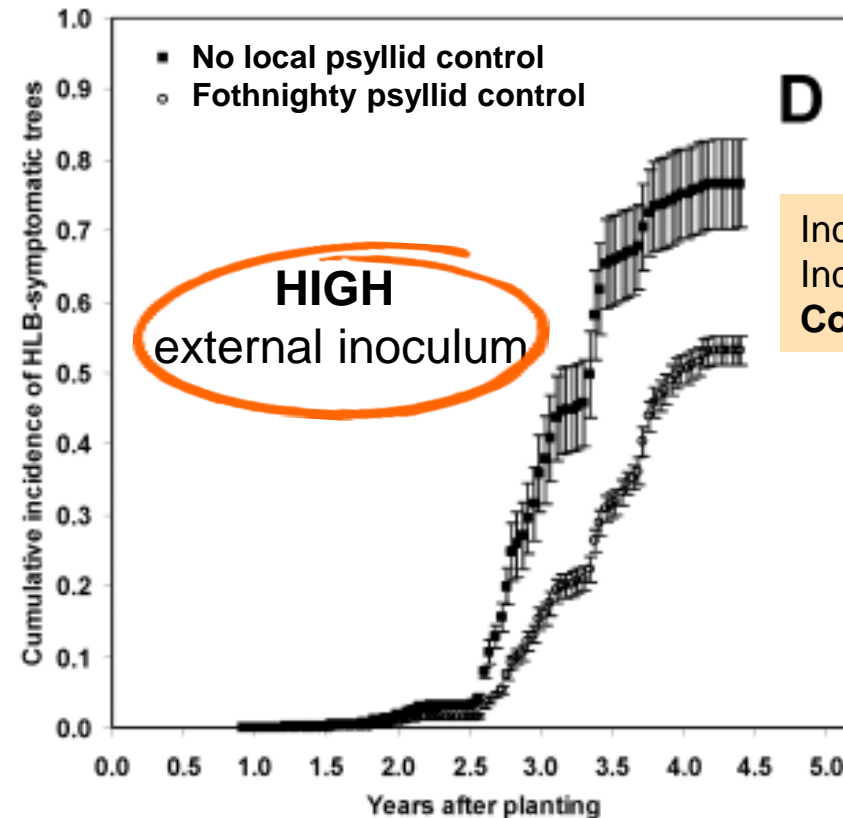
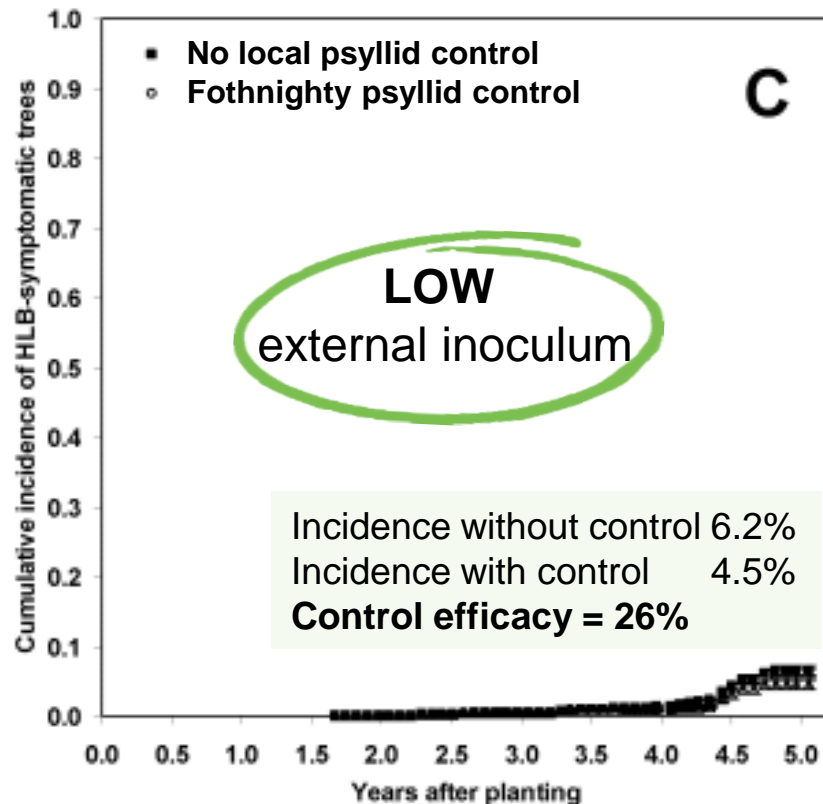
» Great part of infections come from outside

- » Diseased trees in abandoned/bad managed orchards and backyards
- » Constant long-distance dispersal of infectious psyllids



EFFECT OF REGIONAL INOCULUM REDUCTION

- Regardless of the amount of external inoculum source, the effectiveness of controlling primary infections is similar for the same insecticide program
- With the same psyllid control, the higher the external inoculum, the faster the disease progress



Bassanezi et al. Plant Disease 2013

REGIONAL INOCULUM REDUCTION IS ESSENTIAL

» Actions to remove diseased trees inside and outside commercial orchards

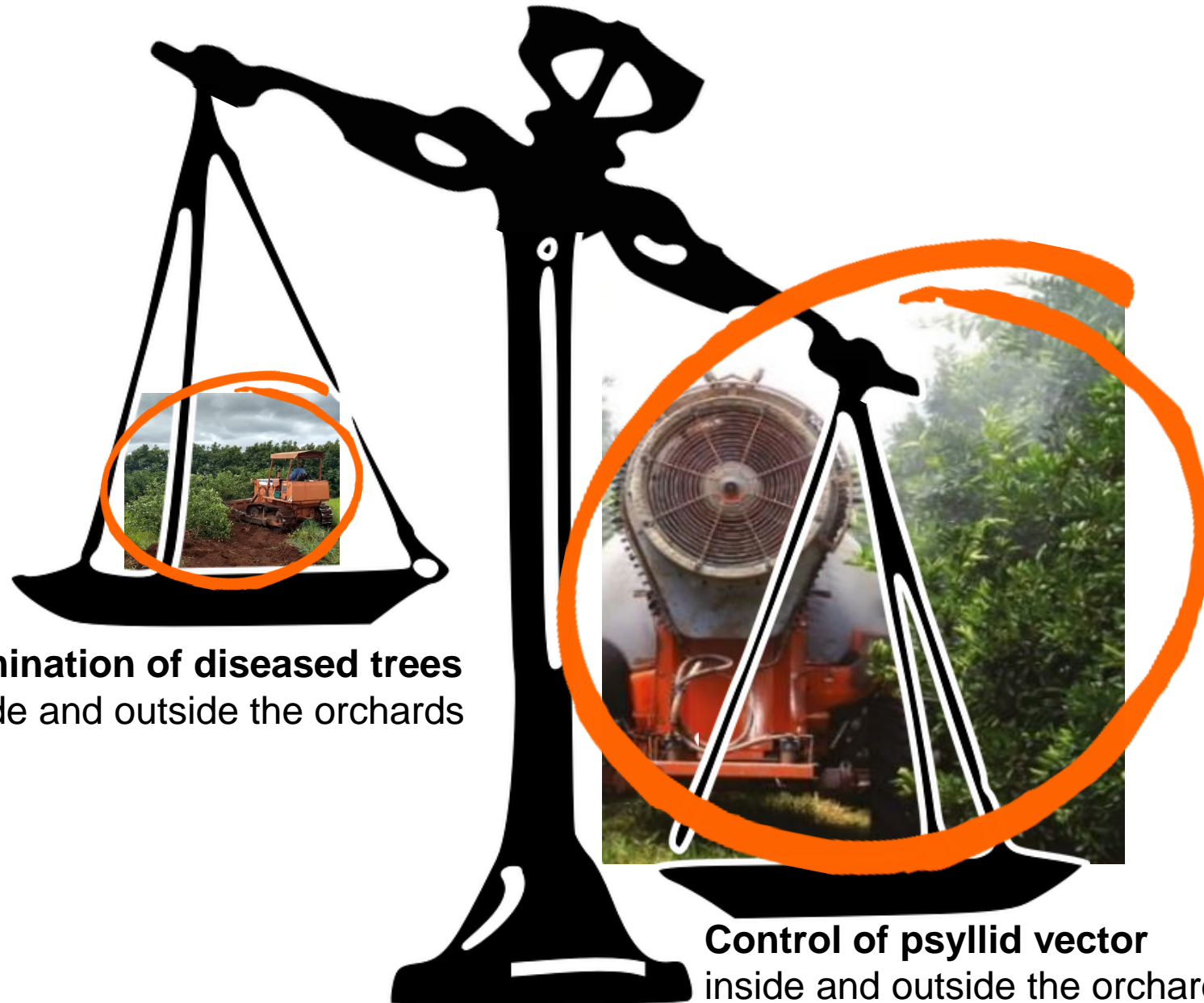


IMPACT OF MAINTAINING DISEASED TREES IN THE ORCHARD



- » Reduction of fruit yield and quality
- » Reduction of orchard economic life span
- » Accumulation of permanent source of bacteria
- » Total dependence on insecticides
 - » to prevent multiple infections
 - » to prevent autoinfection
 - » to prevent infections in the neighbor orchards
 - » to allow new plantings

UNBALANCED PREVENTIVE CONTROL OF HLB: A BIG MISTAKE



Elimination of diseased trees
inside and outside the orchards

Control of psyllid vector
inside and outside the orchards

TOTAL DEPENDENCE ON INSECTICIDE EFFICIENCY

Any failure in the psyllid control program will allow the development of psyllid in diseased trees and it will be lethal

Efficient product and rates



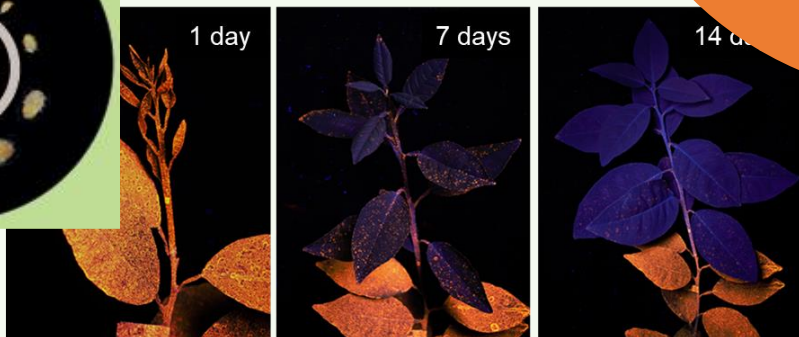
Interval of application



1 day

7 days

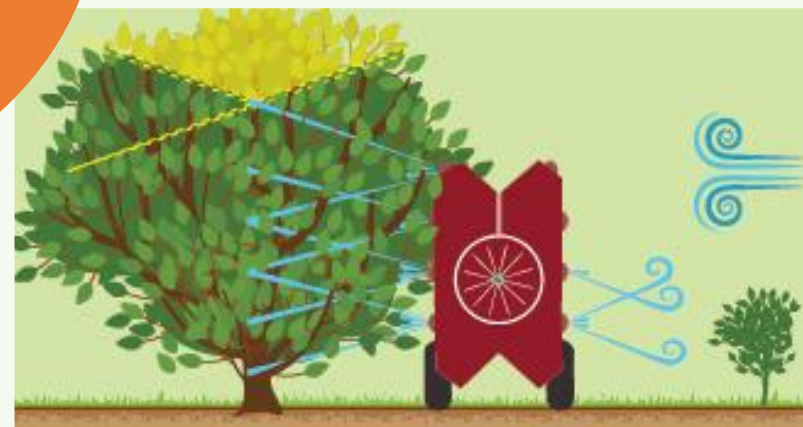
14 days



Rotation of insecticides of different MOA



Spray quality



Pillars of
psyllid
control

INSECTICIDE SPRAYS DON'T COMPLETELY PREVENT INFECTIONS

» Transmission occurs in the new shoot

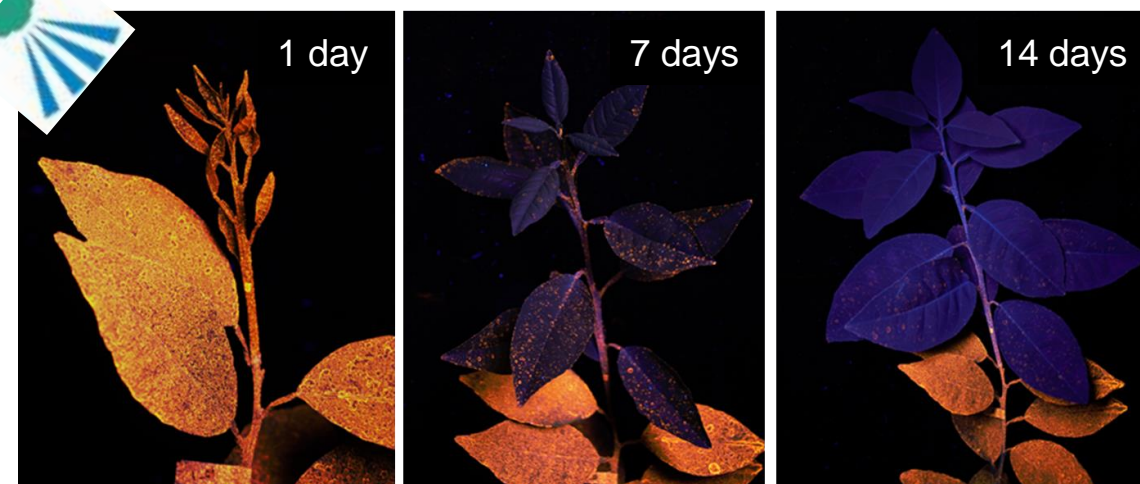
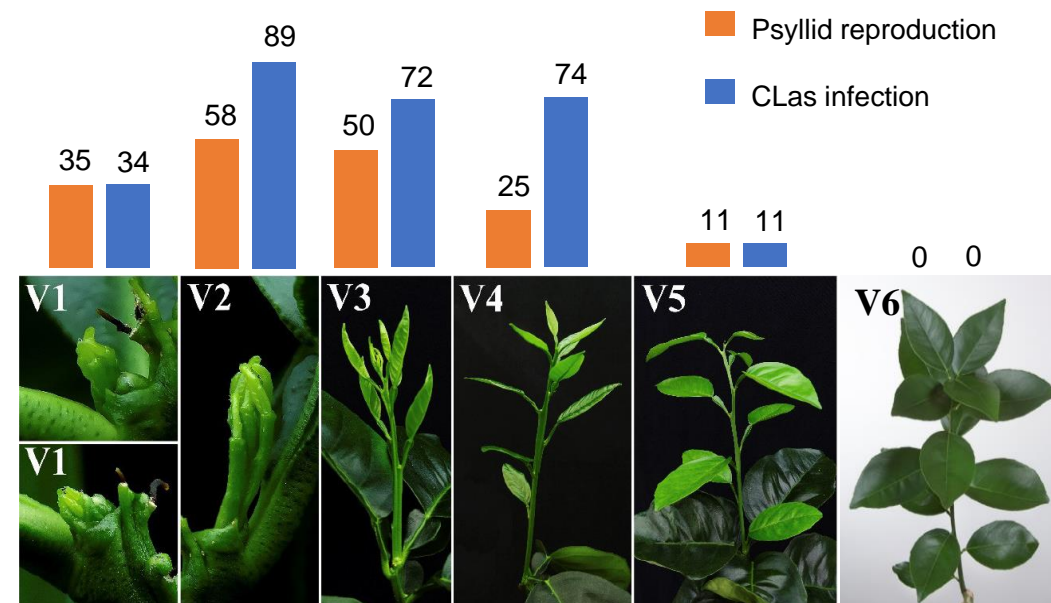
- » Psyllid prefer new shoots to feed
- » >30 min of feeding to transmit

» Difficulty to protect new shoot

- » Difficulty of achieve good spray coverage in the shoots
- » Fast shoot growth exposing unprotected new tissues
- » Efficacy of systemic insecticides only up to the 3rd year
- » No systemicity of insecticides sprayed on the leaves
- » Low residue of contact insecticides
- » Insecticide wash-off by the rain

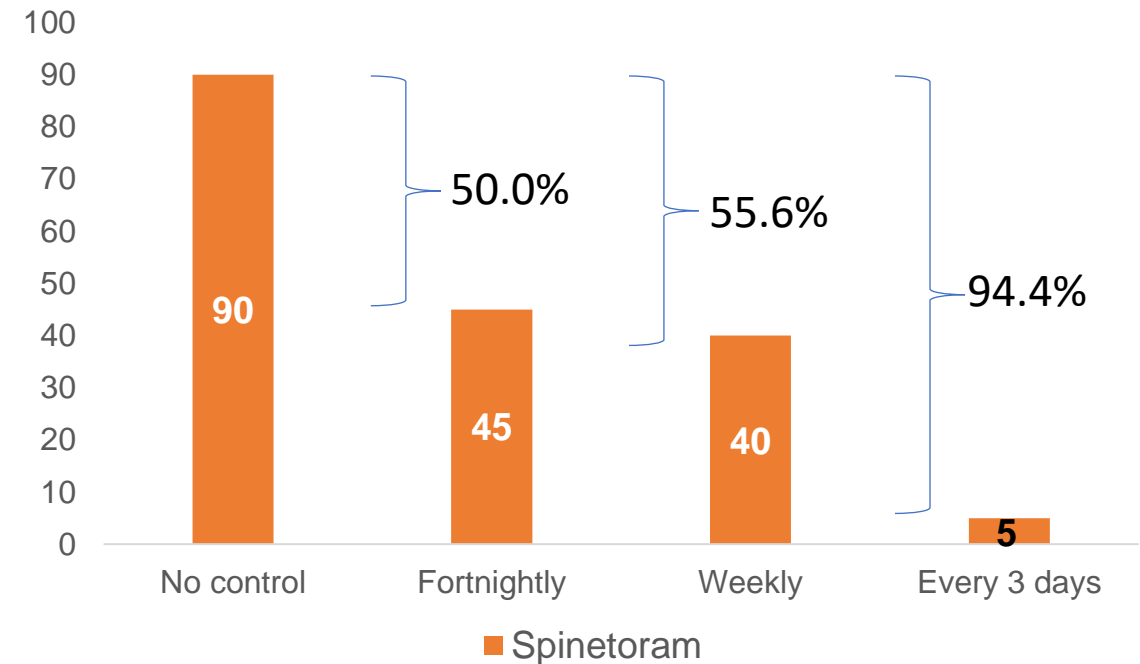
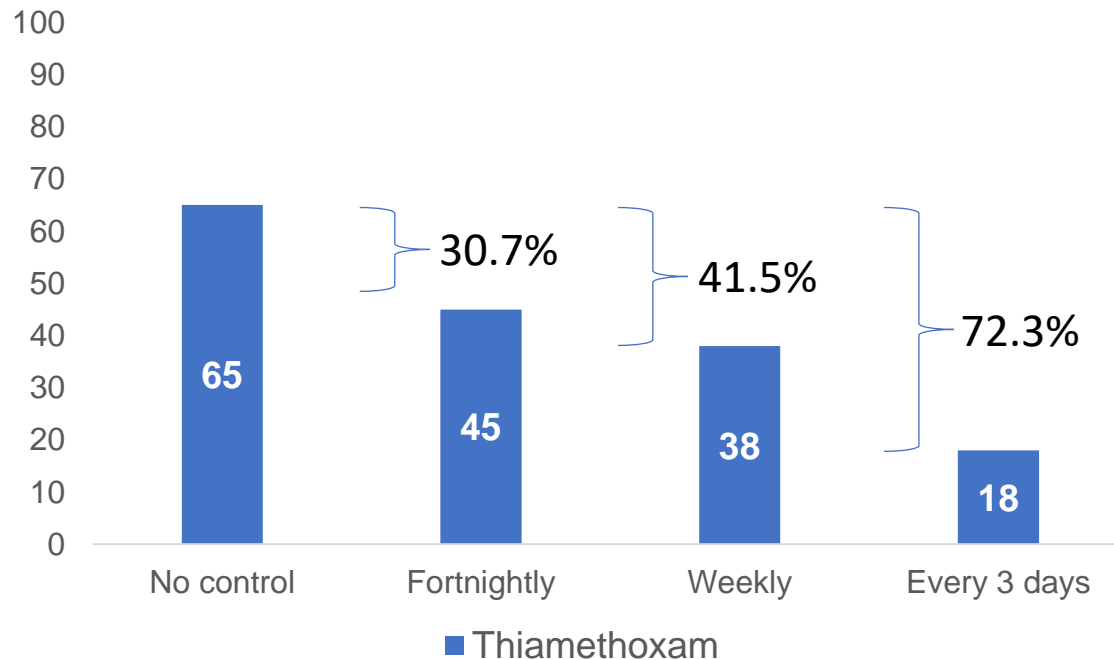
» Continuous sprouting during the year

- » Non-uniformity sprouting between trees and orchards



INSECTICIDE SPRAYS EFFICACY TO PREVENT INFECTIONS

➤ Infection rate (%) of seedlings exposed to infectious psyllids every two days for 2 weeks as function of different frequencies of insecticide spray



Shibutani et al. (not published)

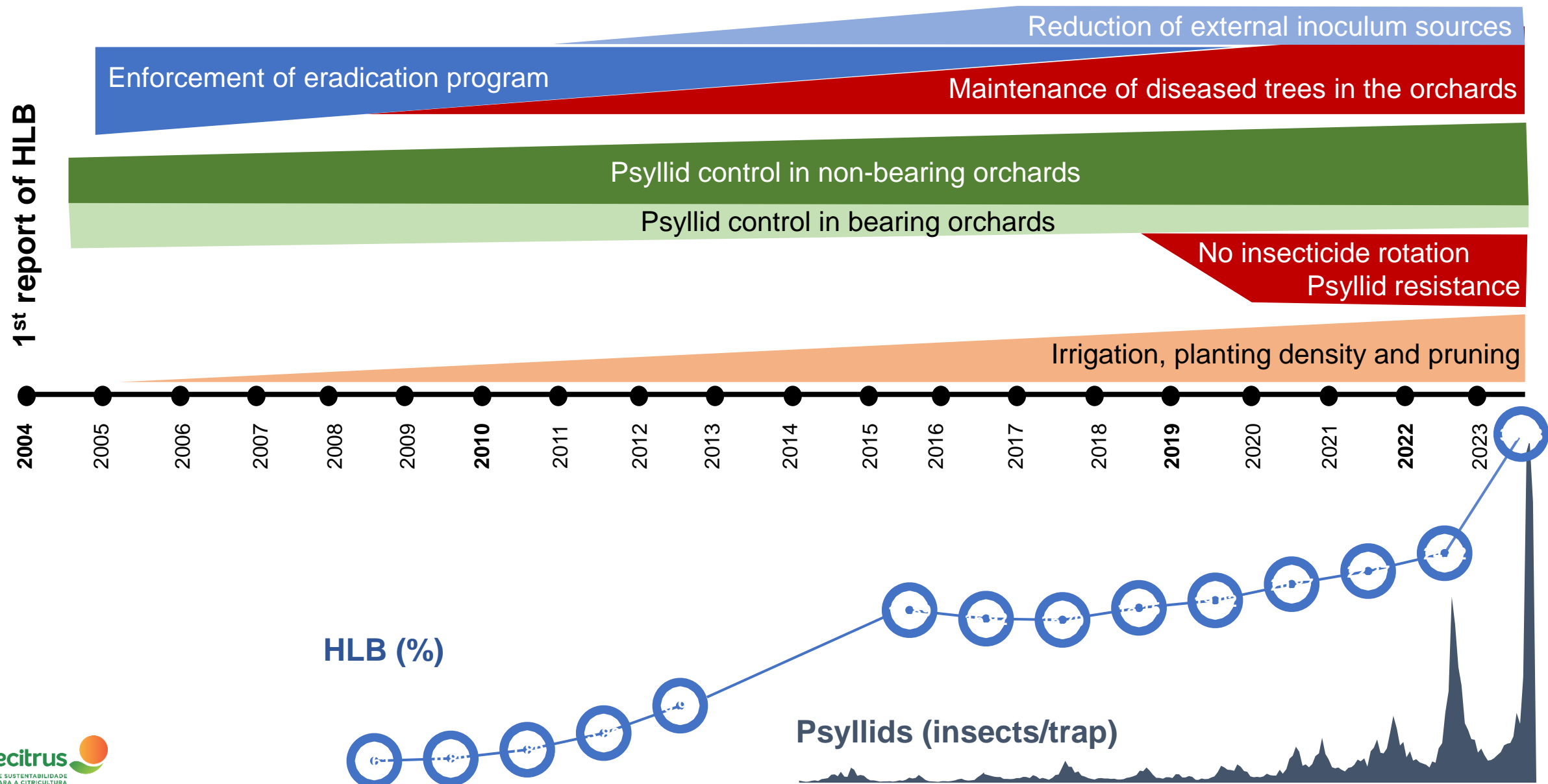
NEED OF BALANCED PREVENTIVE CONTROL OF HLB



Elimination of diseased trees
inside and outside the orchards

Control of psyllid vector
inside and outside the orchards

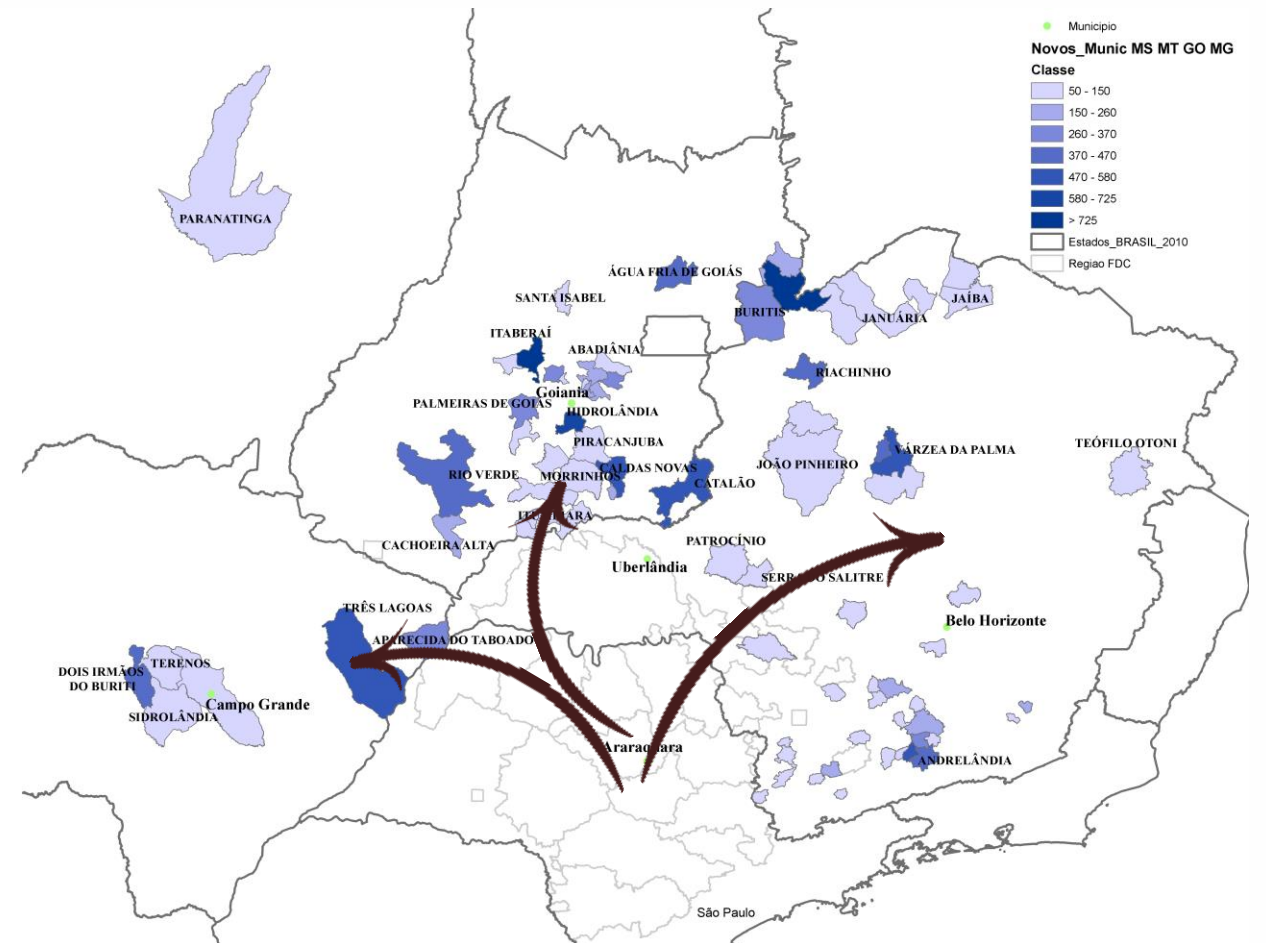
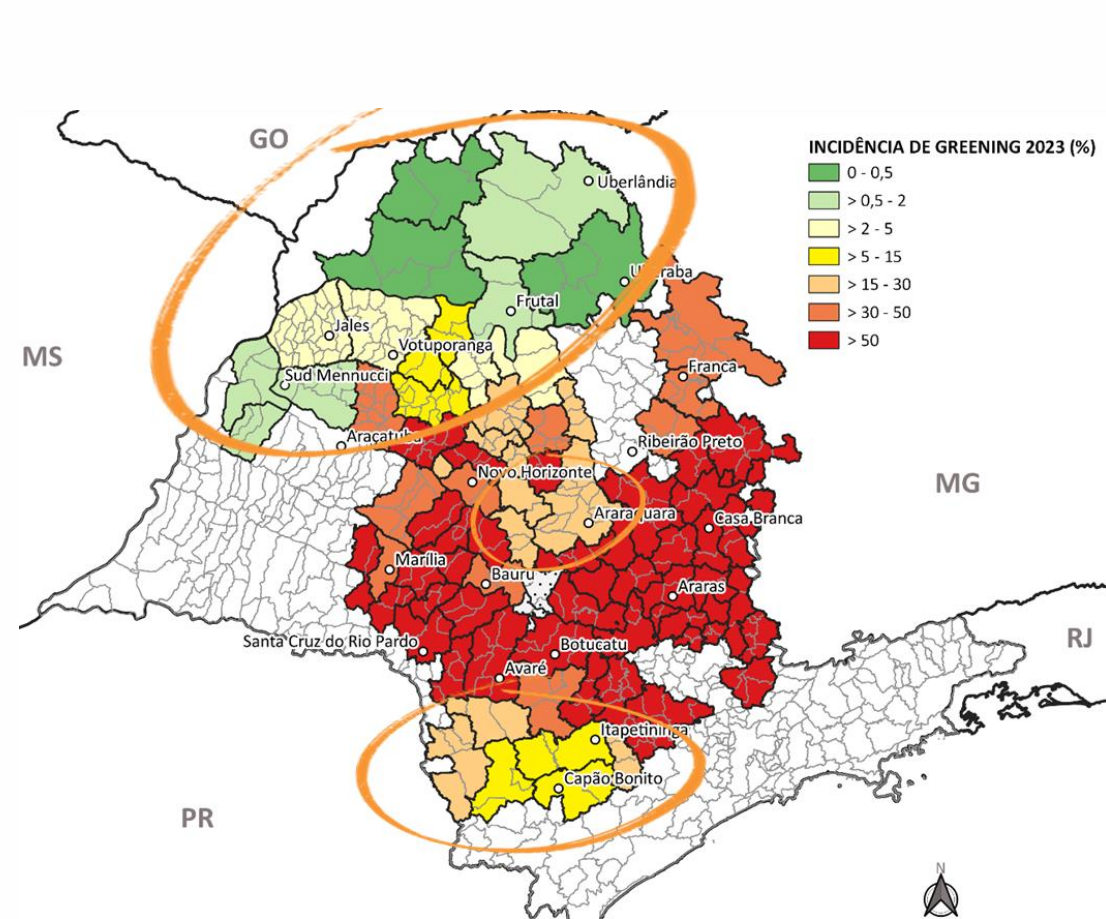
TIME LINE OF HLB CONTROL IN SÃO PAULO CITRUS BELT



MIGRATION OF CITRUS ORCHARDS

➤ New plantings in isolated areas HLB-free or with very low disease incidence

➤ Rigorous psyllid control and **removal of diseased trees** inside and outside new orchards



FINAL MESSAGE

- » So far, there is no resistant/tolerant citrus varieties and no therapy proved to cure diseased trees or keep their yield like that of healthy trees
- » Even diseased tree removal in the orchard do not completely prevent new infections, it stills essential because psyllid control is not perfect too
- » If the incidence of HLB is low, the risk in keeping HLB diseased trees in the orchard is much higher than the benefit.
- » Diseased tree removal and psyllid control must be done in a regional scale (inside and outside commercial citrus orchards) for the success of HLB control



THANK YOU

RENATO B. BASSANEZI
renato.bassanezi@fundecitrus.com.br

fundecitrus.com.br



@fundecitrus



/fundecitrus



/fundecitrus



+55 16 99629 2471



@fundecitrus



/fundecitrus