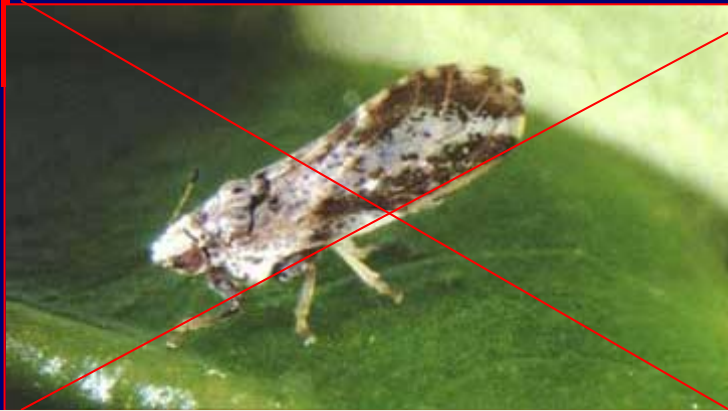
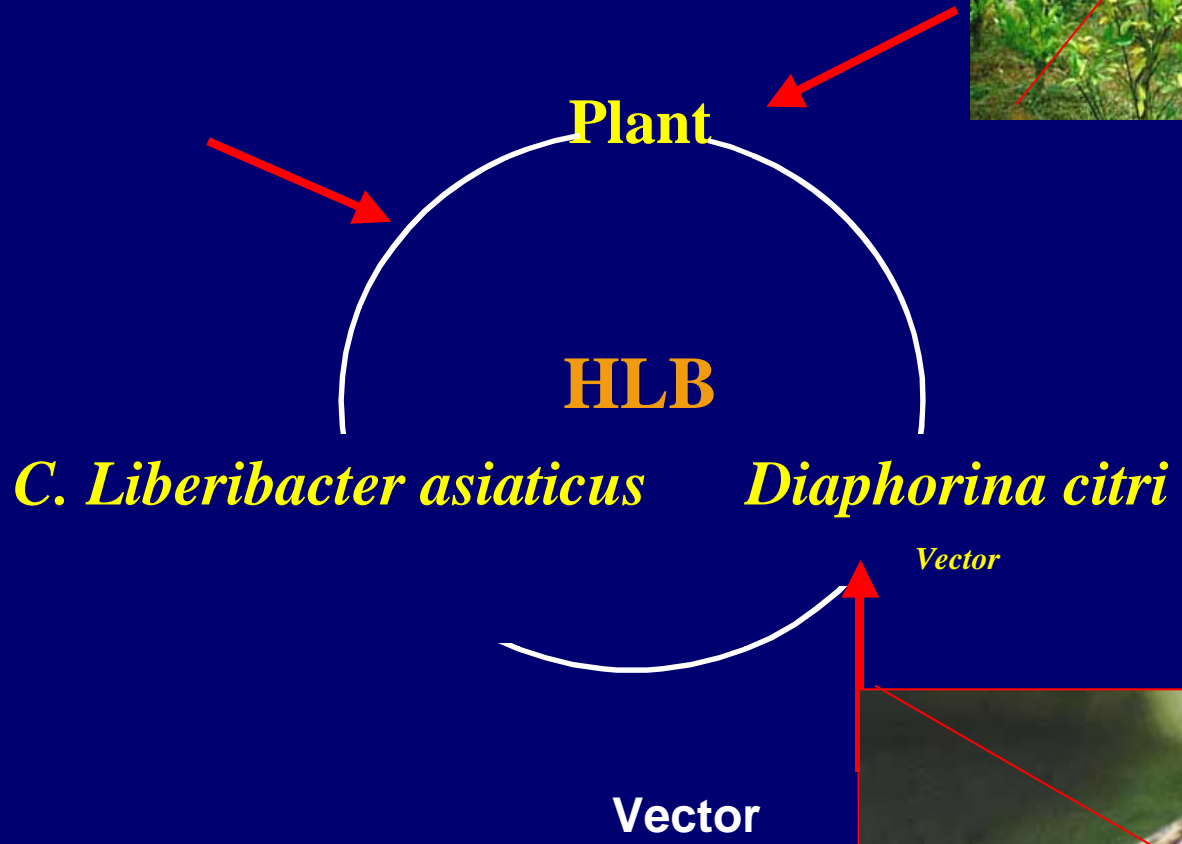


Intercropping of citrus and guava for management of Huanglongbing

D. G. Hall, T. R. Gottwald, N. M. Chau, K. Ichinose, L. Q. Dien, and G. A. C. Beattie





Mottling symptoms



Hanh: Citrus microcarpa

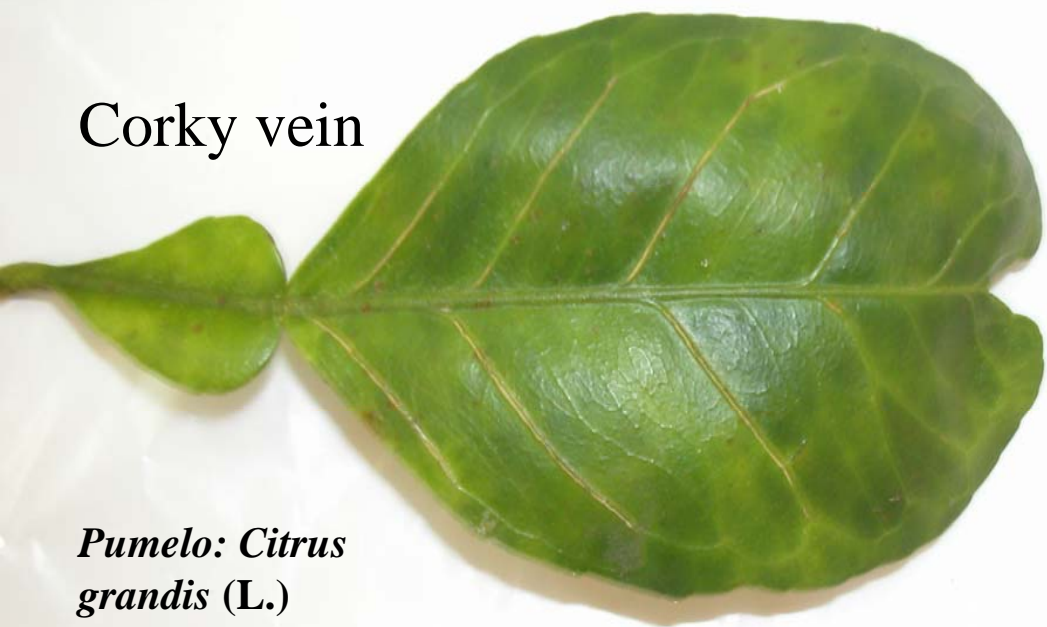


Citrus maxima



*Mexican lime
Citrus aurantifolia*

Corky vein



Pumelo: Citrus grandis (L.)

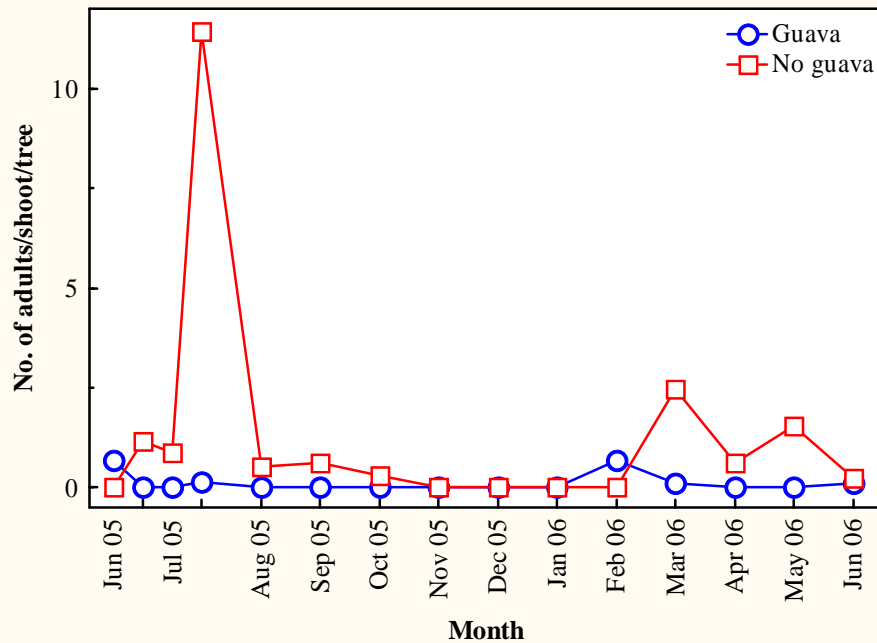


- A meeting was held during December 2006 in Japan (Japanese International Research Center for Agricultural Sciences, Ishigaki, Okinawa-den, Japan)
- Vietnamese, Australian, and Japanese researchers reported that an interplanting of citrus and guava negated infestations of Asian citrus psyllid on citrus and, consequently, incidence of citrus greening disease (huanglongbing).
- They relayed that there are a number of such interplantings in Vietnam but that the effects of guava against psyllids had gone

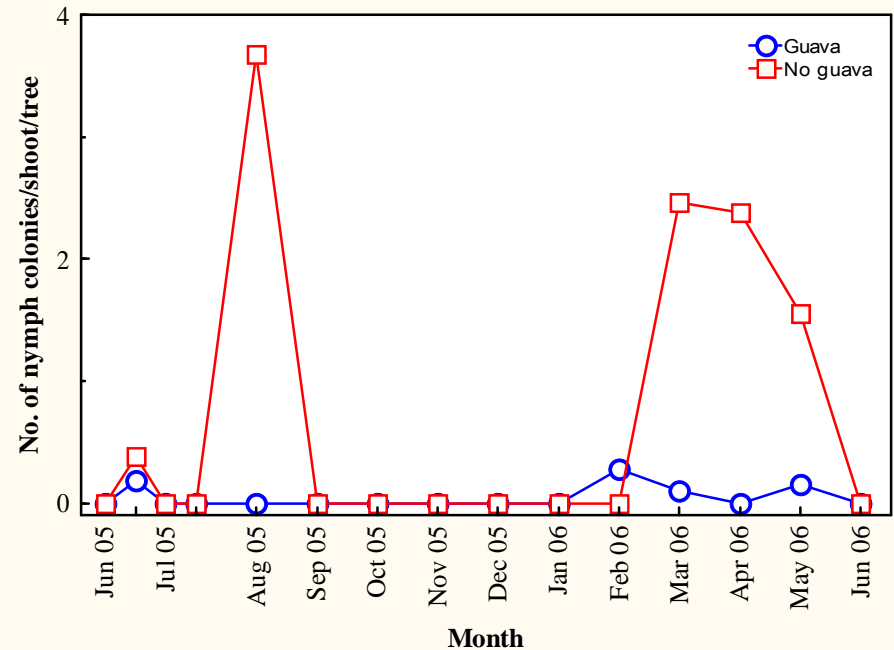


Effect of Citrus/Guava Interplanting on Psyllid Density

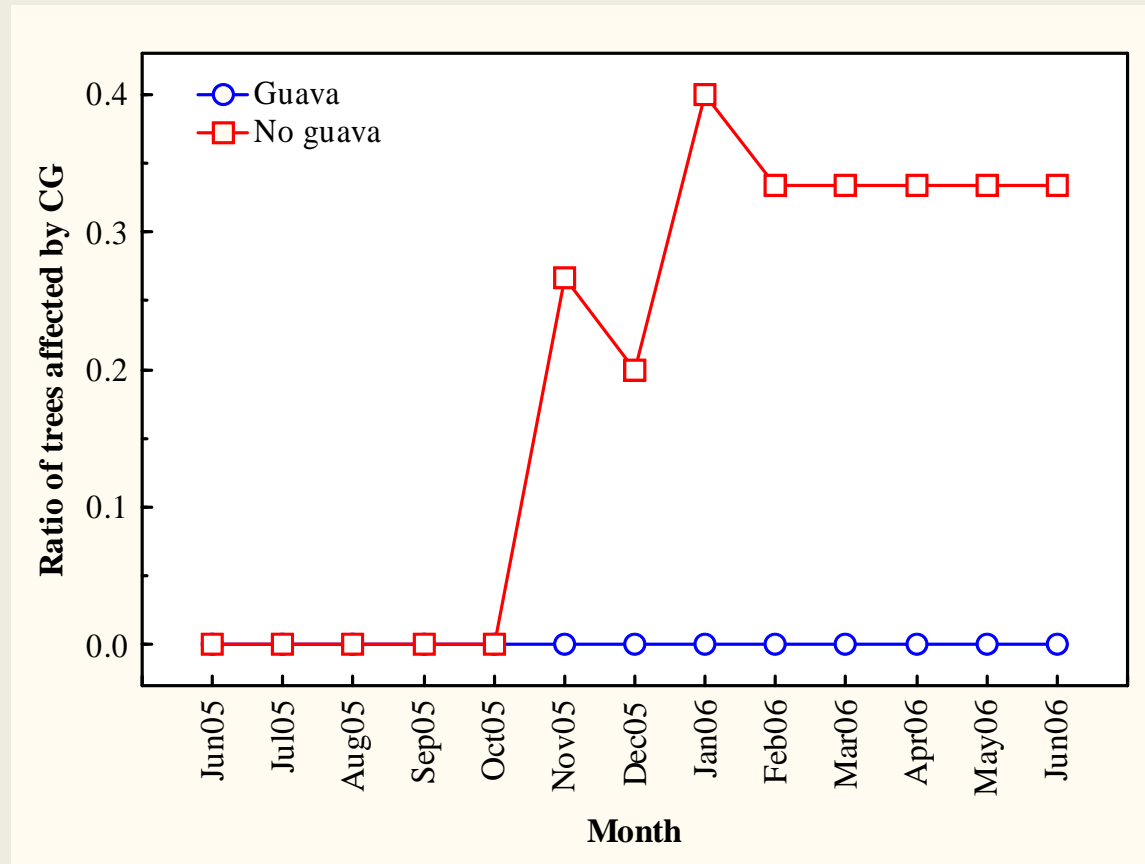
Lower Adult psyllid densities



Lower nymph densities



Disease Incidence (%) HLB



- In Guava-Citrus interplanted orchard no occurrence of HLB
- In Citrus Monoculture orchard Increase of HLB after 5 months
- Anecdotal Observations in Vietnam:
 - Most orchards die out within 2-3 years
 - In other places in South Vietnam where they practice guava interplanting, farmers report 15-yr old orchards with little HLB

➤ Reasons that the presence of guava in a citrus grove negated infestations of the psyllid are unclear.

➤ Speculate that there may be volatiles associated with guava that interfere with the psyllid's ability to find and infest citrus, or that repel psyllids.

➤ In choice tests, adult psyllids preferred not to settle on leaves treated with extracts of guava leaves (hexane, acetone). The researchers speculated that **terpenoids** present in guava were responsible for repellency.



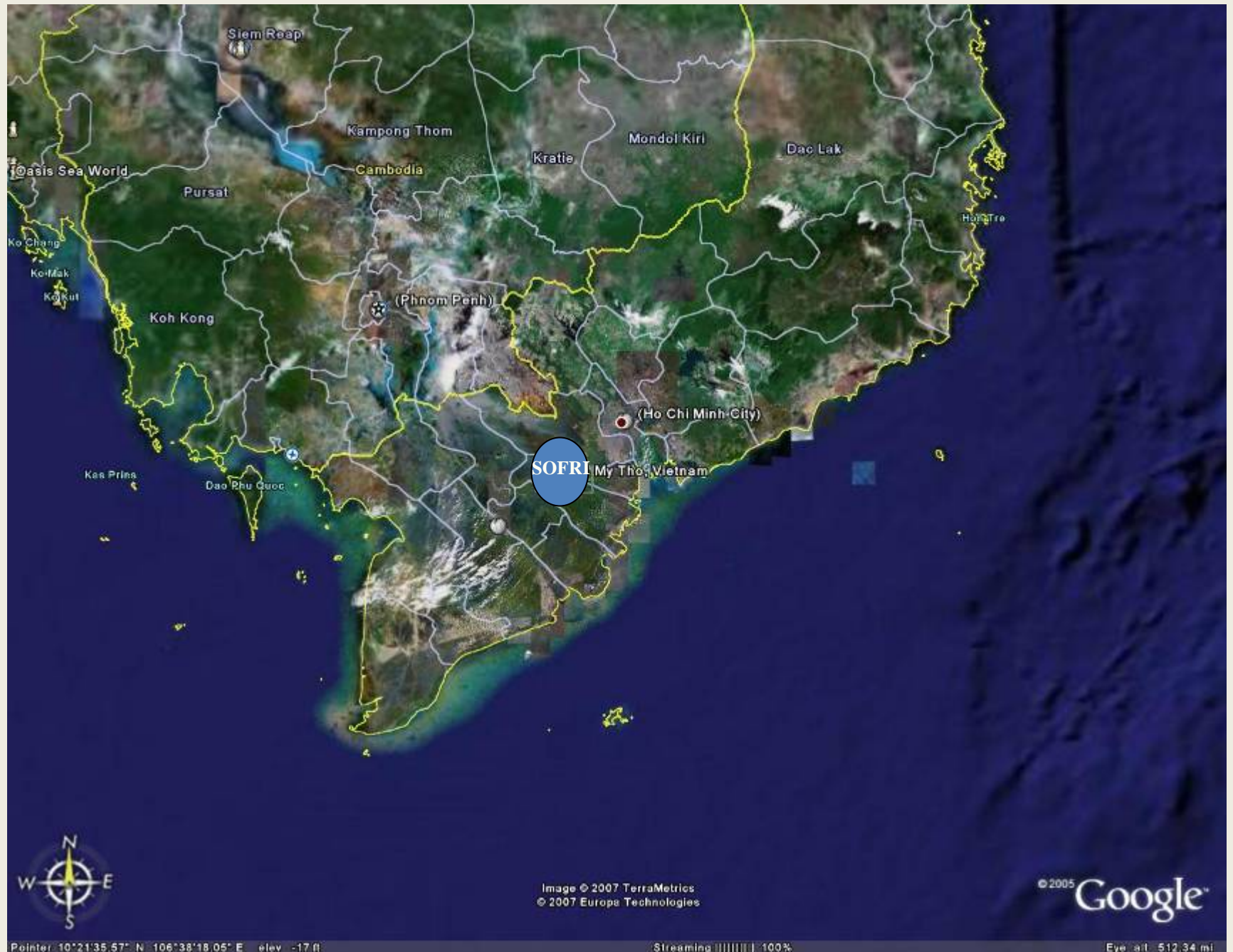
USDA-ARS along with three Florida Citrus Industry Representatives visited South Vietnam during April 23 – 27, 2007, to see interplantings of citrus and guava.



Darrell McCullough
Consolidated Citrus

Mike Stewart
Consolidated Citrus

Tim Gast
Southern Gardens
Citrus



SOFRI My Tho, Vietnam



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Mekong Delta and My Tho



- Mekong Delta is at about 9° north of equator.
- North and South Vietnam are separated at about 16° . North Vietnam climate more like Florida, South Vietnam is hotter.

Hosts:

Dr. Katsuya Ichinose (JIRCAS - Entomologist) and Dr Tim Gottward
and Dr. David Hall (USDA-ARS) and Dr Andrew Beattie (Entomologist,
University of Western Sydney)

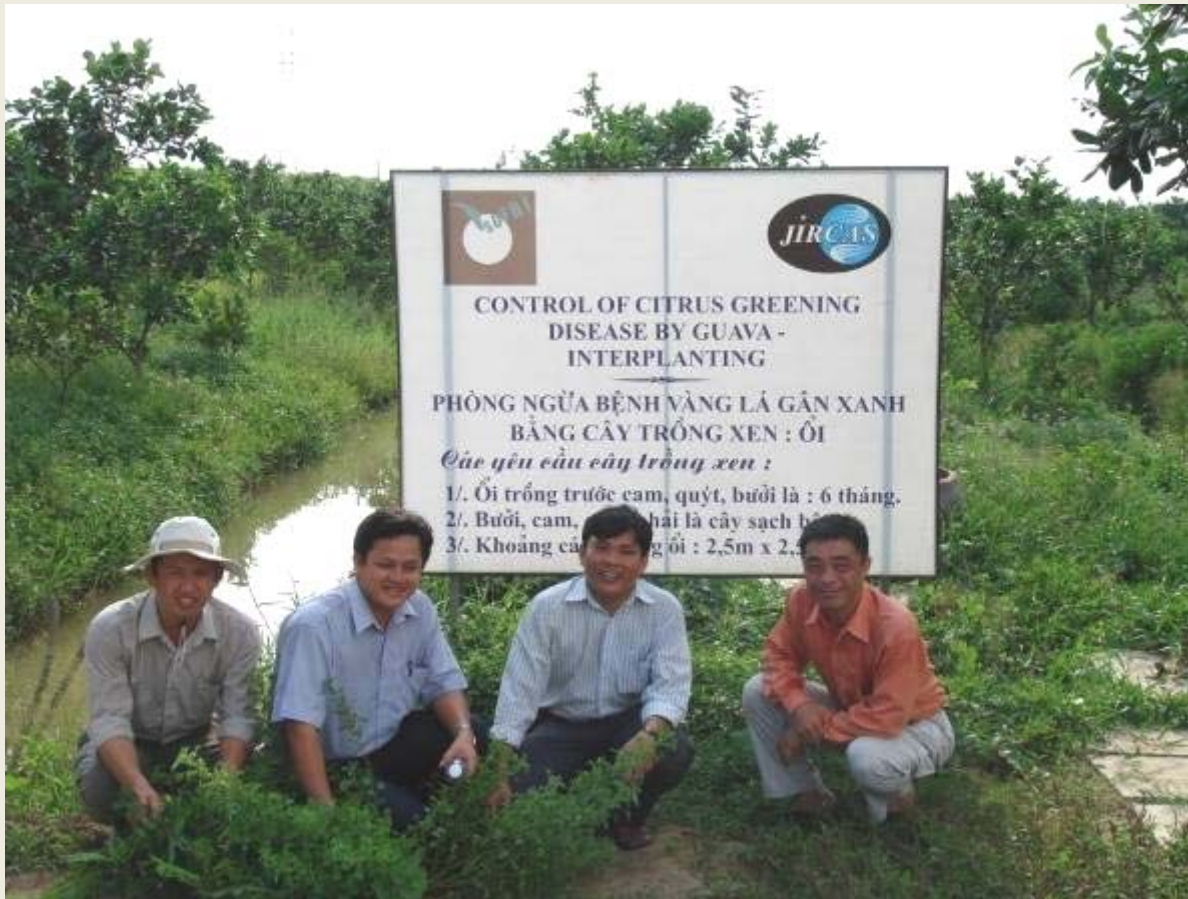


Vietnam Scientists:

Dr. Nguyen Van Hoa (Head, SOFRI Plant Protection Division, Plant Pathologist)

Mr. Le Quoc Dien, Entomologist

Mr. Do Hong Tuan, Entomologist



Dr. Andrew Beattie
(Entomologist,
University of Western
Sydney)



Citrus production in South Vietnam is considerably different than in Florida.

Most farms in Mekong Delta area are in the order of 0.5 ha with a tree of spacing of 2.5 m and row spacing of 2.5 m.



In most of the interplantings of citrus and guava, equal numbers of citrus and guava trees are planted with a tree of spacing of 1.5 m and row spacing of 1.5 m. No heavy equipment is used.









Site 1: Original study plots, not replicated.

-King Mandarin interplanted with guava versus monoculture of King Mandarin

-**INTERPLANT** situation – **NO PSYLLIDS** found on the citrus trees, 10% infection after 2.5 yr

-**Monoculture** situation – 75% citrus trees infected after 2.5 yr, diseased citrus have now been replaced with guava

Site 2: king mandarin **INTERPLANTED** with guava, citrus and guava were 7 years old. - The guava was much taller than the citrus, 9 to 12 ft tall guava versus 8 to 10 ft tall citrus.

- Had recently removed guava to increase citrus production because citrus was bringing more money than guava.

-**COULD NOT FIND PSYLLIDS**

Site 3: A **MONOCULTURE** of citrus, one group of trees 3 yr old and one group 6 yr old

- **MANY PSYLLIDS** observed in these trees

Site 4: Young pummelo/guava **INTERPLANTED**.

- **NO PSYLLIDS** could be found on citrus, disease incidence low

Site 5: An **INTERPLANTED** plot of 1.5 year old guava and pummelo.

- **NO PSYLLIDS** found, but some leafminers were observed on the citrus.

- Yellow sticky cards (8.5 x 11 inches) but no psyllids on these cards.

Site 6: A **monoculture** of pummelo, 1.5 years old

- Little flush present. Did not find any psyllids.
- Disease present

Site 7: Lime interplanted with guava and lime planted alone, 3 years old.

- **Many psyllids** in the **monoculture** plot.
- **NO PSYLLIDS** in the **INTERPLANTED** plot.

Site 8: 3-year-old **INTERPLANTING** of King Mandarin with white guava bordered by a row of melaleuca.

- Some disease present, estimated 20% trees infected after 3 years
- Leafminer observed, but **NO PSYLLIDS**
- Some signs of old damage by psyllids to leaves

Site 9: 10-year-old **INTERPLANTING** of King mandarin and white guava.

- Trees looked healthy for the most part, some HLB infection observed
- We **COULD NOT FIND PSYLLIDS**.

Site 10: 15-year-old **INTERPLANTING** of King Mandarin and white guava trees.

- Guava was very tall.
- A low percentage of trees infected by HLB.
- We **COULD NOT FIND PSYLLIDS**

After returning from Vietnam, They initiated greenhouse studies.

Fig. 1. Percentage mortality of adult psyllids in a no-choice test, 5 different guava types vs citrus.

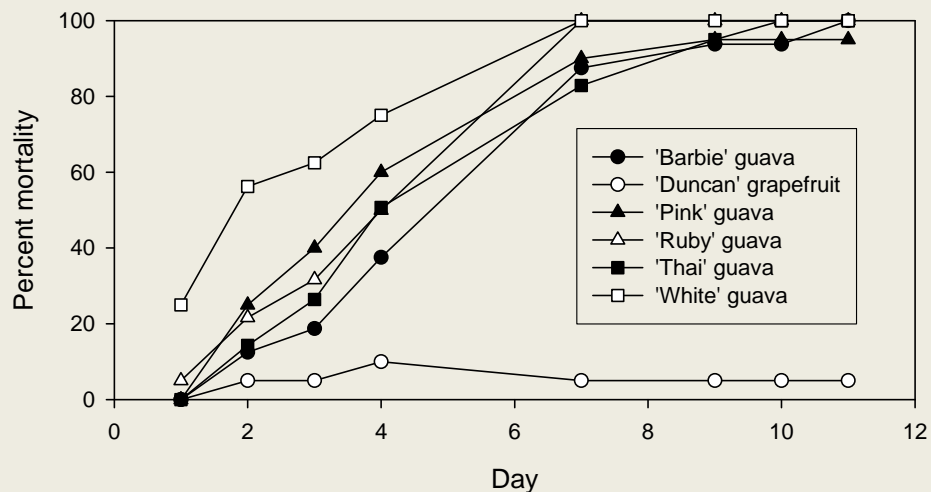


Fig. 2. Percentage mortality of adult psyllids in a no-choice test, 4 types of guava vs citrus vs cotton

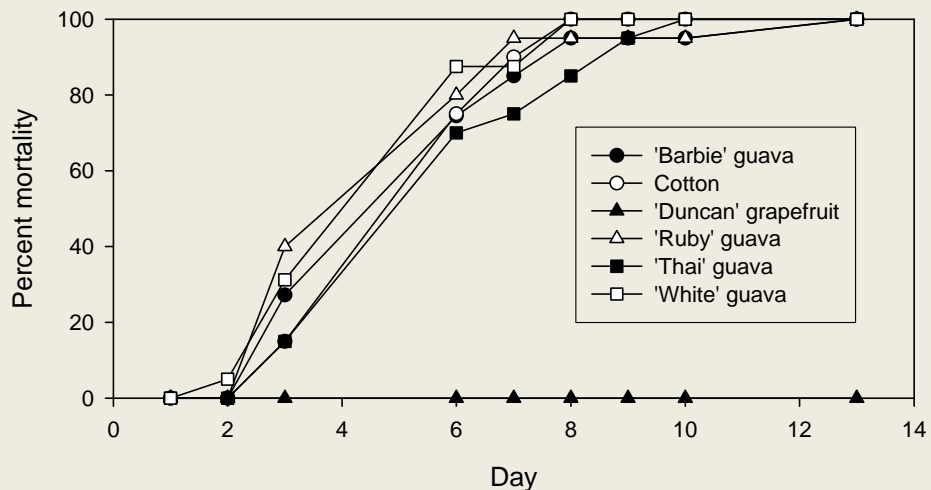


Fig. 3. Average 'Area Under Curve' analyses on % dead psyllids over time

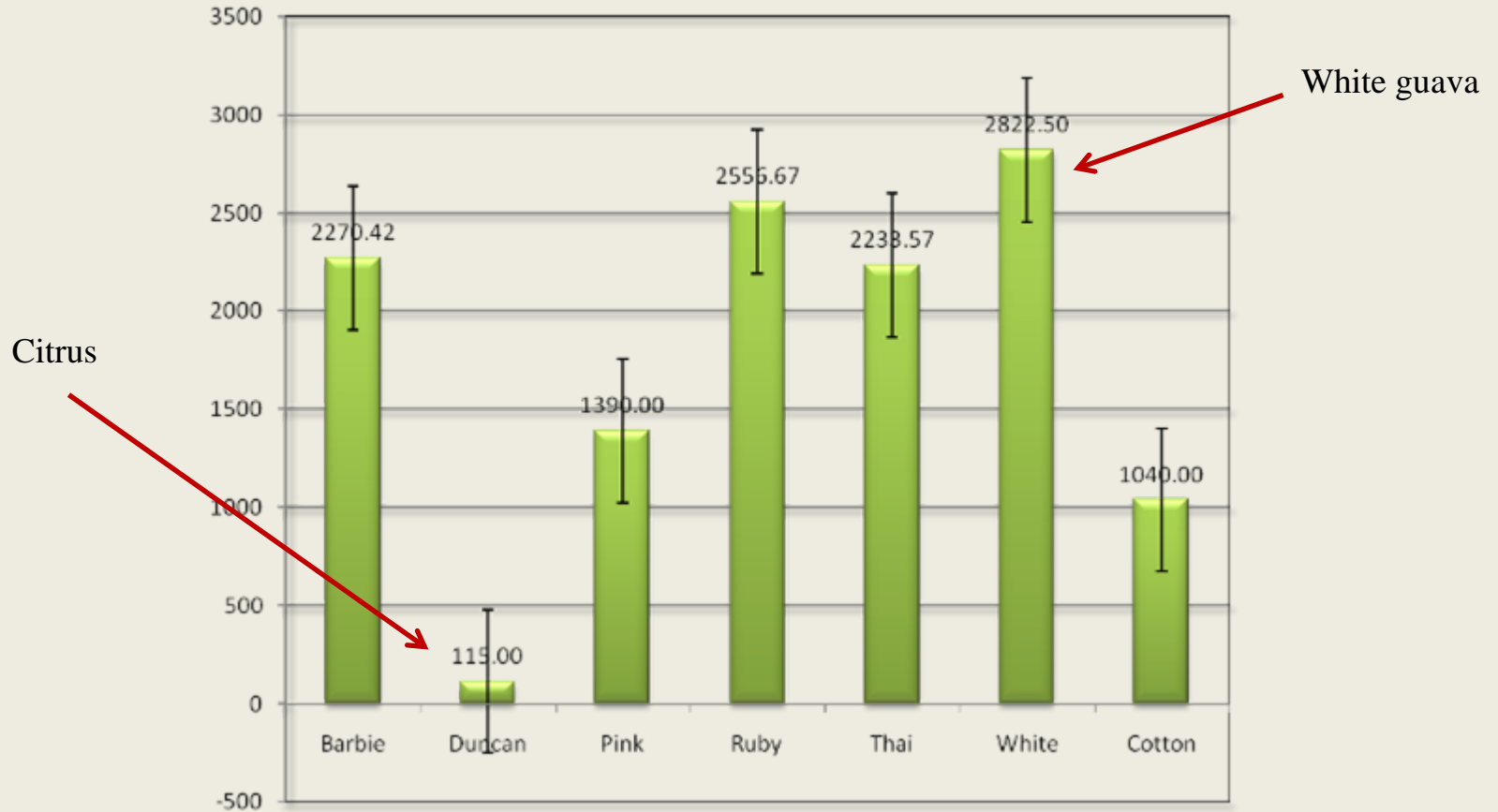
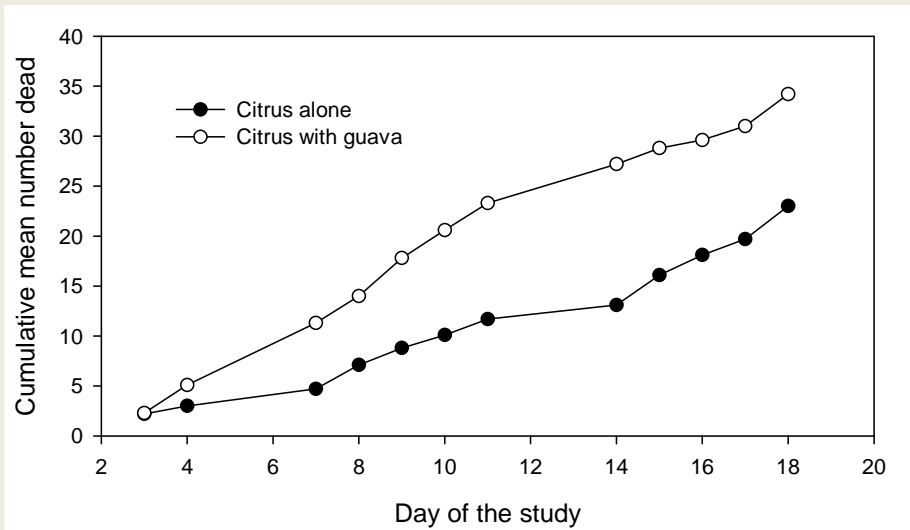


Fig. 4. Cumulative death of adult psyllids in a cage with citrus alone versus in a cage with both citrus and white guava.



citrus alone:

$Y = -3.05 + 1.32X$, $F = 465.6$, $Pr > F = <0.0001$, $r^2 = 0.81$, 107 df.

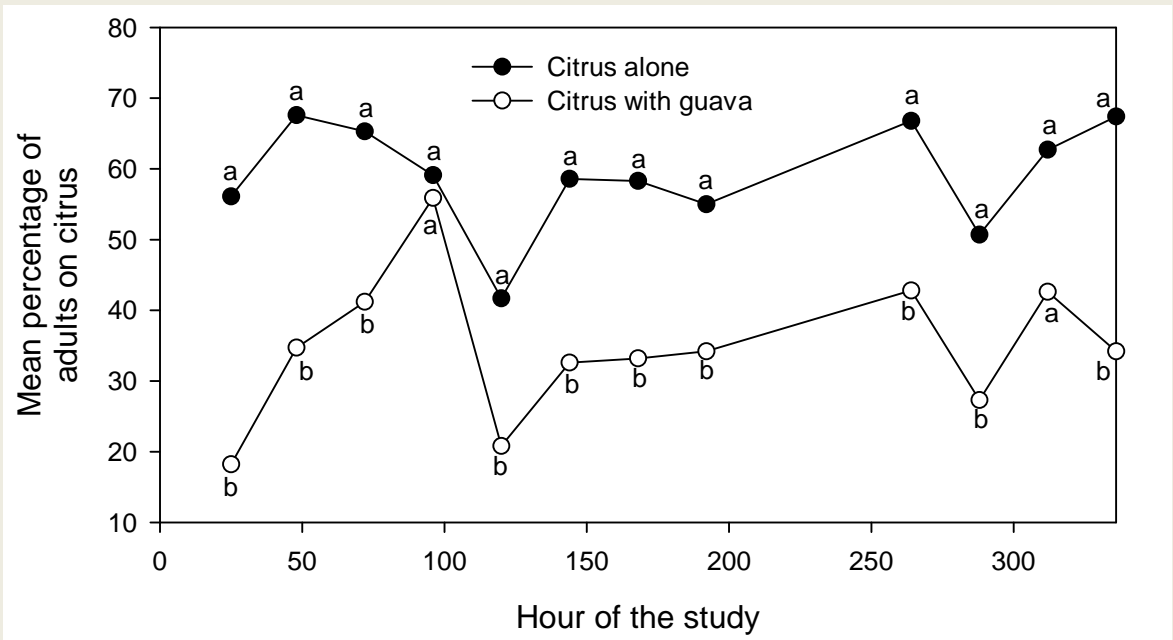
both citrus and guava:

$Y = -2.24 + 2.06X$, $F = 307.1$, $Pr > F = <0.0001$, $r^2 = 0.74$, 107 df.

The slopes from these regressions were significantly different, indicating that mortality rates were faster among adults in cages with both citrus and guava.



Fig. 5. Mean percentage of live adult psyllids on citrus in a cage with citrus alone versus in a cage with both citrus and white guava.



Conclusion

- ❖ Greenhouse studies indicated that adult psyllids cannot survive on guava, particularly white guava
- ❖ There was evidence from greenhouse studies that the biology of the psyllid is negatively effected when citrus and guava are grown together
- ❖ No evidence of any acute negative effect in preliminary tests
- ❖ Whether the Vietnamese guava **phenomenon** can be duplicated in Florida citrus remains to be determined. Planting density in Vietnam may play a role in the guava effect against psyllids

❖ Large scale, replicated experiments have been initiated with Consolidated Citrus and Southern Gardens Citrus of Florida.

❖ In Vietnam, large scale replicated experiments will test different type guavas and citrus density.

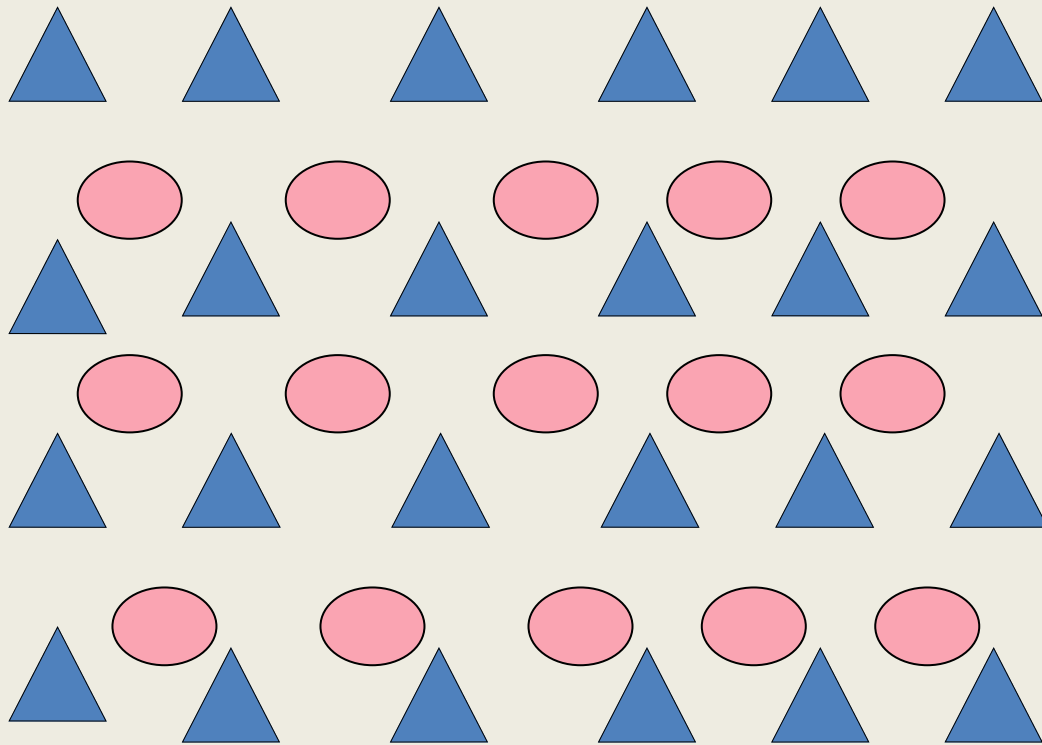
❖ we had trained to 100 farmers in Mekong Delta in VietNam.

Saigon (Ho Chi Minh City) Central Market Fruit Stand





- The first, we grow guava
- After 8 months, we grow citrus
- Citrus should be free disease



Distance plant

Guava : 2.5m x 2.5m

Citrus : 5m x 5m





Bagging fruit





Running citrus tree



Mottling symptoms



Hanh: Citrus microcarpa



Citrus maxima



*Mexican lime
Citrus aurantifolia*

Corky vein



Pumelo: Citrus grandis (L.)



Citrus reticulata Blanco



Citrus grandis (L.)



Sweet orange (*Citrus sinensis*)

Duong mandarin

Tieu mandarin

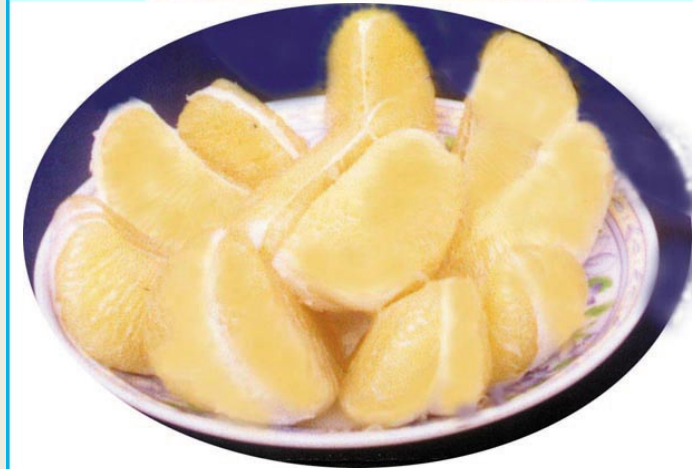
King mandarin





Mat orange

B-ëi N'm roi [*Citrus maxima* (Burm.) Merr.]



B-ëi Da xanh [*Citrus maxima* (Burm.) Merr.]

