Use of physical barriers to promote root health

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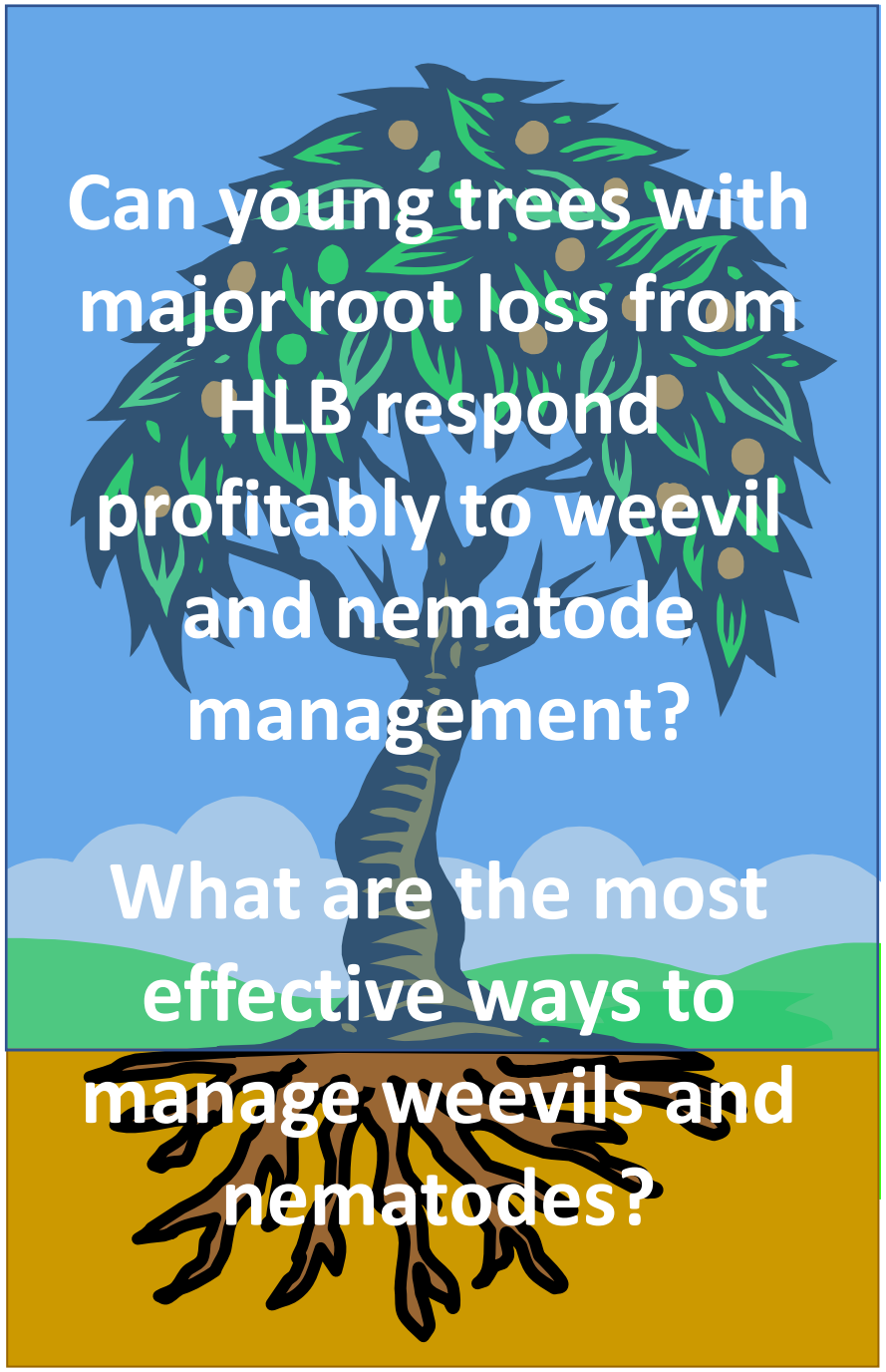
CREC

Until recently all young trees in Florida contracted HLB.

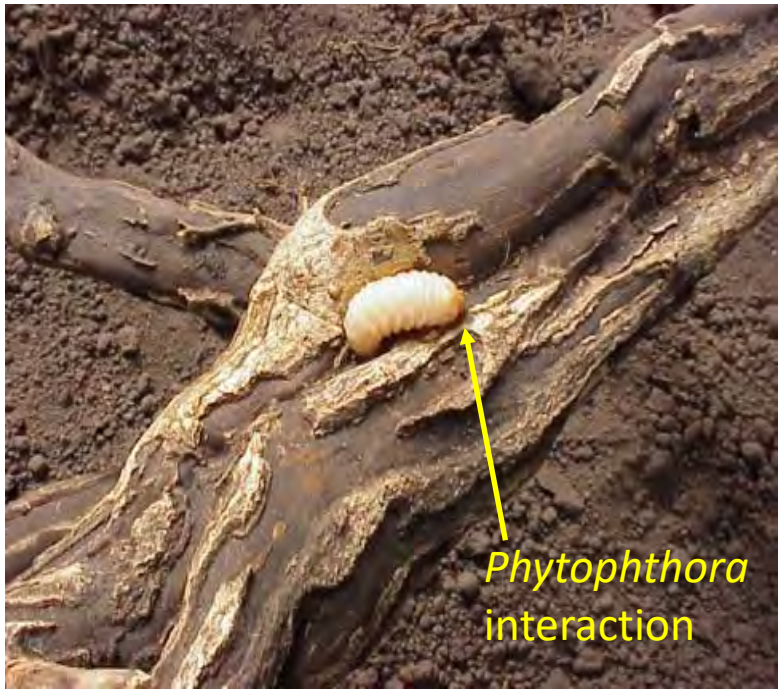
These trees lose half their feeder roots before symptoms are visible in the canopy.

Can young trees with major root loss from HLB respond profitably to weevil and nematode management?

What are the most effective ways to manage weevils and nematodes?



- ✓ Answering the first question requires HLB-affected and unaffected trees in the field. Individual Protective Covers – IPCs – provide the means to do this.
- ✓ IPCs and use of landscape fabric may also be the most profitable means of weevil management.
- ✓ IPC use may also be a means to increase tree tolerance of nematodes and weevils by increasing the age at which trees become HLB-positive.



Diaprepes abbreviatus
(and other root weevils)

Life cycle

- ✓ Adults lay eggs in canopy and upon hatching larvae fall to soil.
- ✓ Larvae feed on roots, pupate and adults emerge from soil.
- ✓ *All year long except coldest months*

Management

- ✓ Spray canopy with insecticides and ovicides that have short residual activity. *When no longer working, new adults emerge from soil, mate and lay eggs*.
- ✓ Kill larvae in soil with nematodes that have short residual activity. *When no longer working new larvae fall to soil*.
- ✓ Rootstocks that tolerate *Phytophthora*
- ✓ Soil drainage

Waist-high trees with roots damaged by HLB and *Diaprepes* root weevil

Chin-high trees with roots undamaged by HLB or *Diaprepes* root weevil. Neither psyllids nor weevils have access to foliage

Adjacent blocks heavily infested by *Diaprepes* root weevil. Both replanted because of weevil damage.

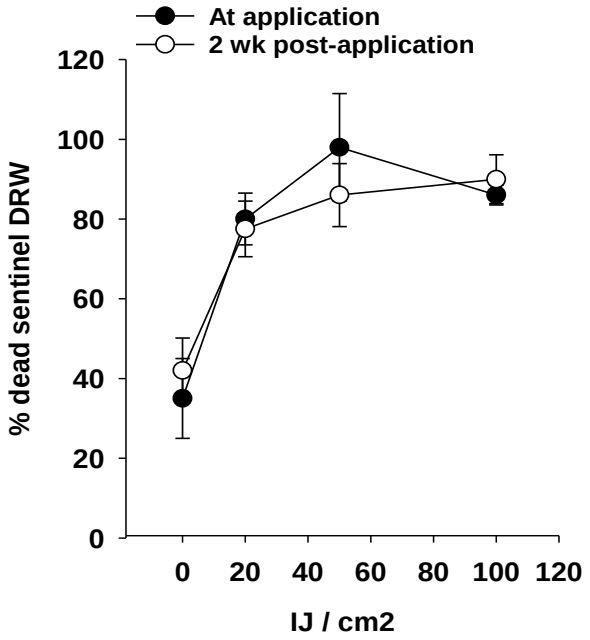
- ✓ Older trees on left treated with insecticides and twice annually with *Steinernema riobrave*.
- ✓ Younger trees on right one year after ICP removal.

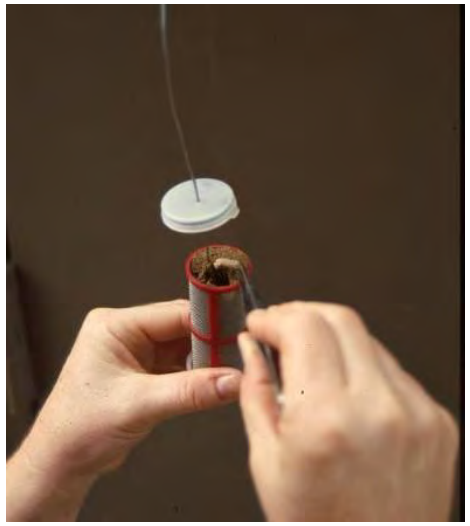
IPCs

- ✓ prevent psyllid feeding – No HLB
- ✓ prevent weevil egg laying – No root herbivory.
- ✓ IPCs have increased tree growth tremendously.

What happens when the covers are removed?

- ✓ trees will contract HLB
- ✓ weevils will resume their cycle of feeding on leaves and roots
- ✓ are there improved management tactics?

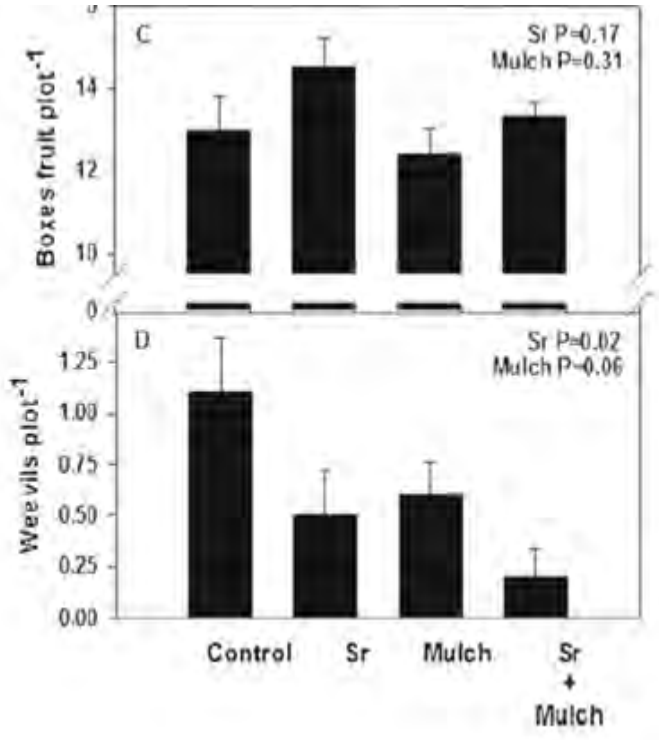




Entomopathogenic nematode efficacy (Nemasys R®)

Immediate effect

- ✓ 70-90% of buried weevil larvae killed by nematodes within one week.
- ✓ Efficacy decreases after several weeks.



Net effect (two applications annually)

- ✓ 50% annual reduction of emerging adults.
- ✓ Non-significant yield increase in two long-term trials.

All profitability trials occurred prior to arrival of HLB.

Use of entomopathogenic nematodes following IPC removal…TBD.

- ✓ Treat only the crown.
- ✓ A spray pattern of 2-ft radius requires 6-fold fewer nematodes than a patterns of 5-ft radius.
- ✓ Treating with nematodes at 6-week intervals may afford better (continuous) tree protection than treating a larger portion of the root system one or twice a year.

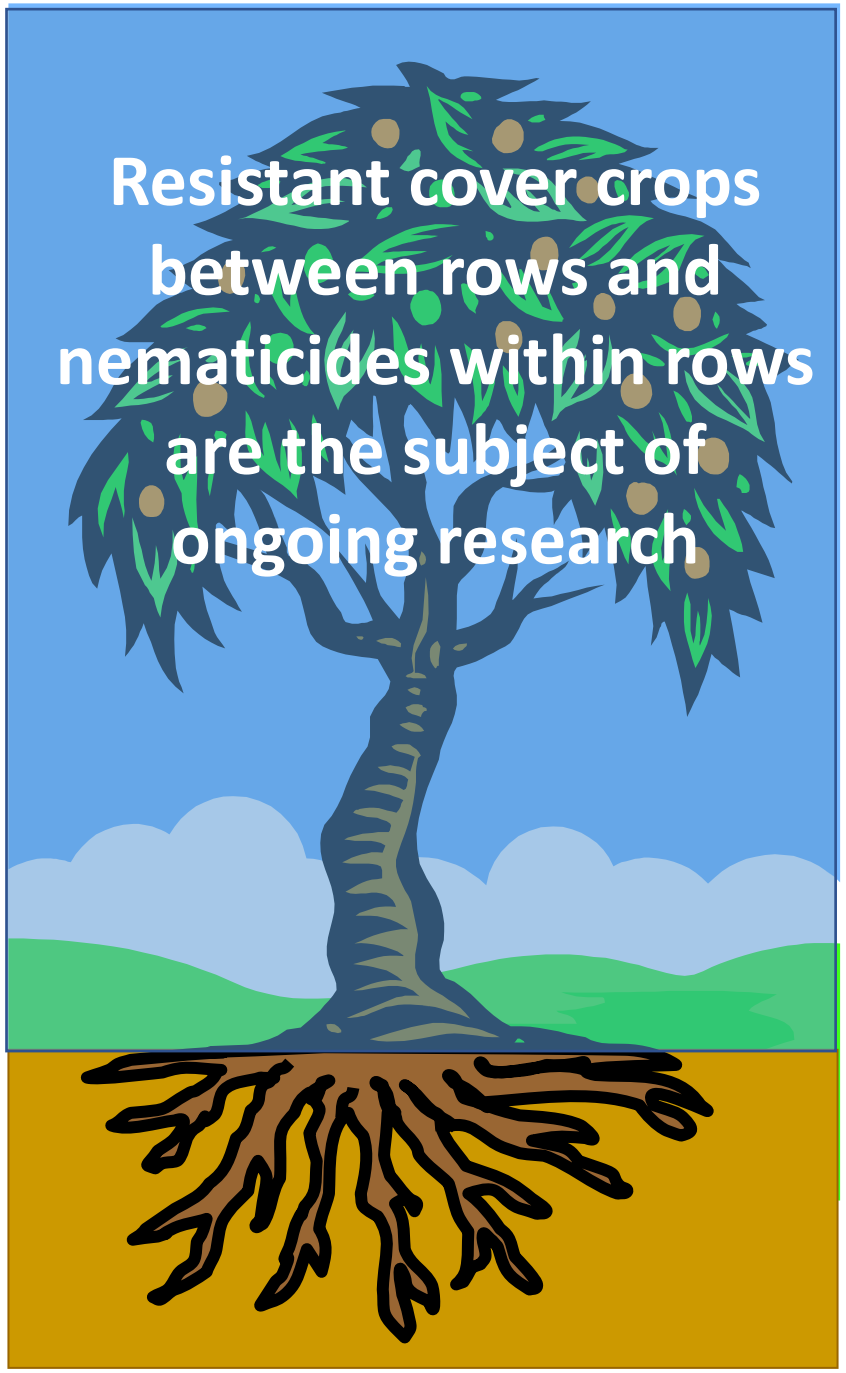
Damage to the crown is likely more detrimental to tree health than damage to the lateral root system.

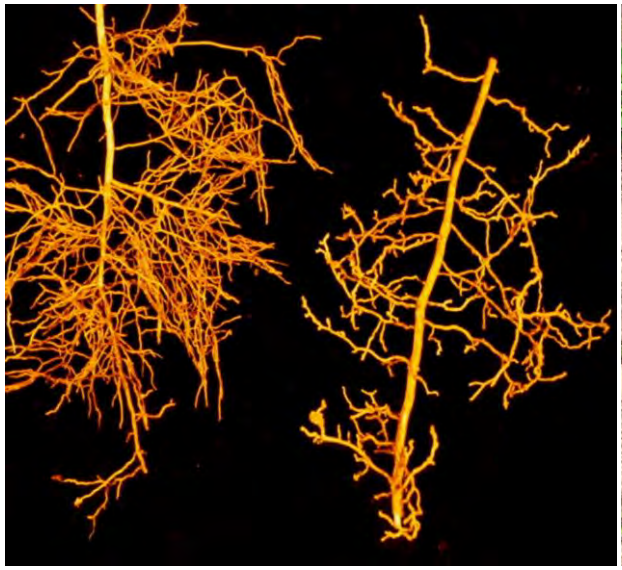
Landscape fabric mulch

- ✓ Blocks weevil entry and exit from soil.
- ✓ Increased tree growth in several Florida trials.
- ✓ Protected lemon trees from *Diaprepes* in California.
- ✓ Used currently for *Diaprepes* management in Texas.
- ✓ >200 acres installed recently in Florida.
- ✓ High installation cost offset by elimination of weed management in tree rows, increased water-use efficiency, reduced pest management costs.
- ✓ Critical to use fabric with high water infiltration.

Commercial examples in Florida are being implemented.

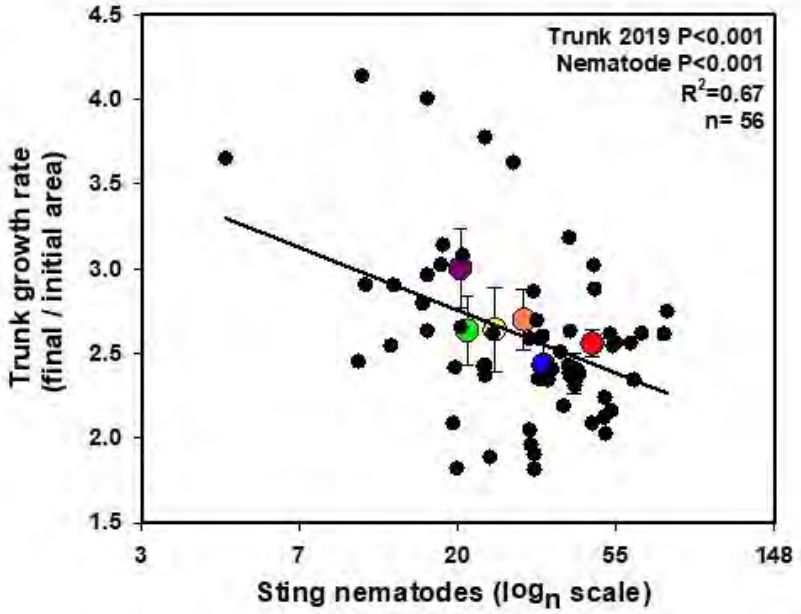
- ✓ Block of trees replanted two years ago due to severe damage by *Diaprepes abbreviatus*.
- ✓ To date, no tree loss or evidence of damage by weevils….
- ✓ An ideal fit for growers interested in:
- Organic production
- Use of cover crops in middles for soil improvement and increasing plant diversity and biological control.

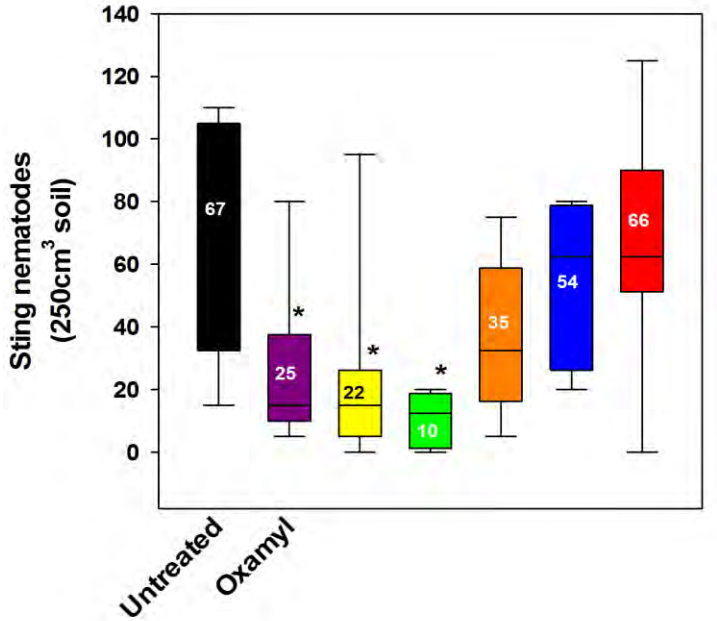

Resistant cover crops between rows and nematicides within rows are the subject of ongoing research

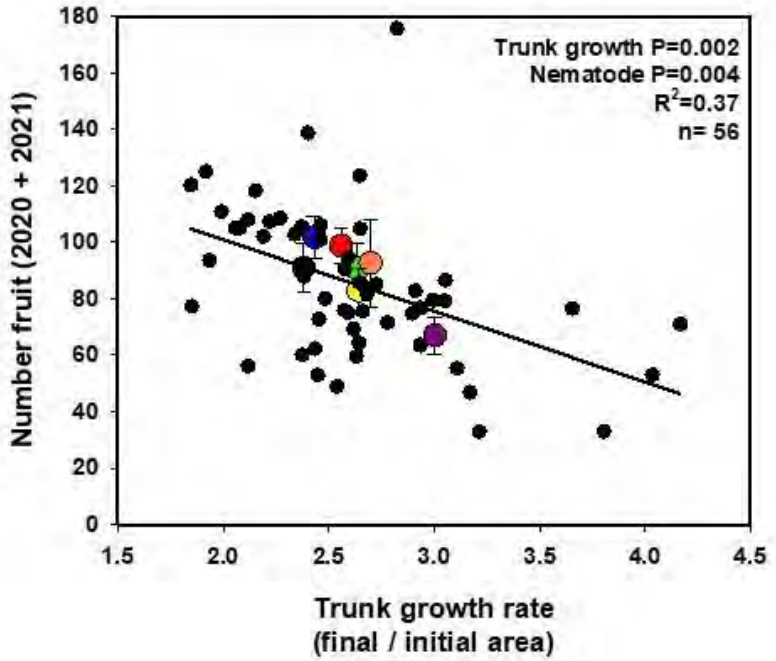


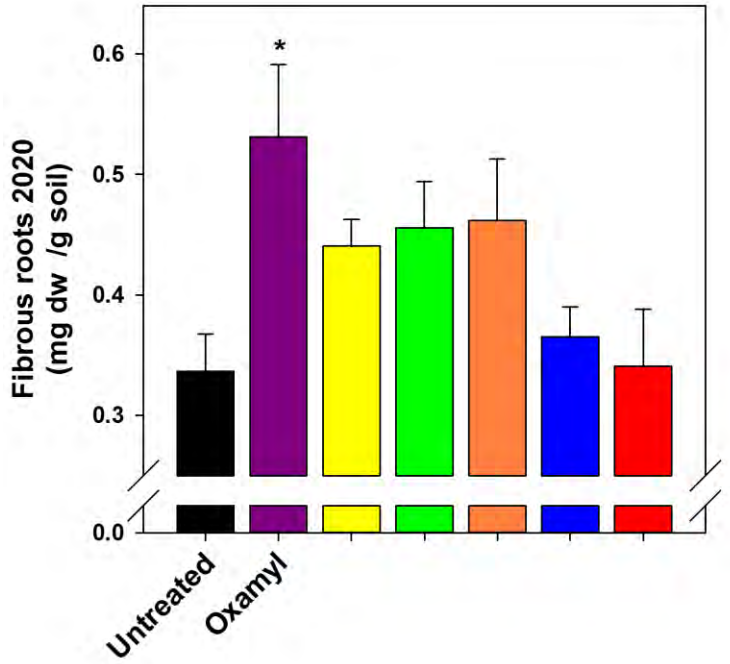
Sting nematode (*Belonolaimus longicaudatus*)

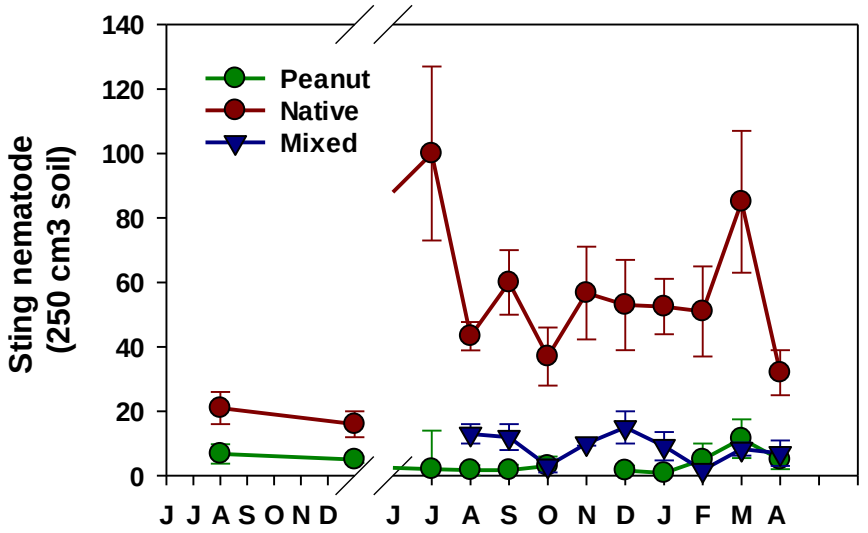
- First recognized as widespread pest of young trees during freezes of 1980s-90s.
- Large size, adapted to coarse, sandy soil.
- Feeds at root tip, causes stubby root symptoms.
- Moves downward when soil dries.
- Very wide host range, including many weed species.

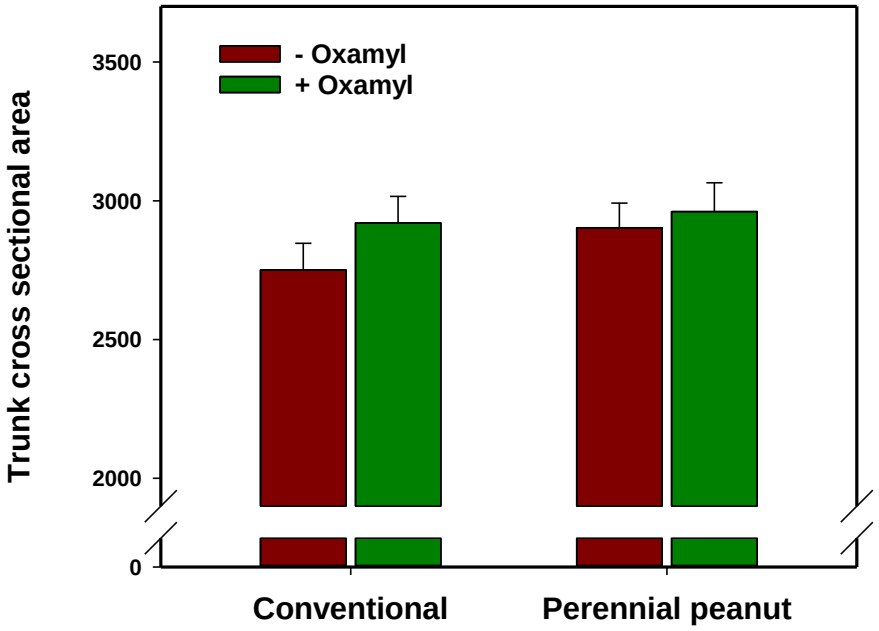

Trunk 2019 P<0.001
Nematode P<0.001
R^2=0.67
n= 56
Trunk growth rate (final / initial area)
Sting nematodes (log_n scale)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
3
7
20
55
148


Sting nematodes (250cm^3 soil)
140
120
100
80
60
40
20
0
67
25
22
10
35
54
66
*
Untreated
Oxamyl


Trunk growth P=0.002
Nematode P=0.004
R^2=0.37
n= 56
Number fruit (2020 + 2021)
Trunk growth rate (final / initial area)
180
160
140
120
100
80
60
40
20
0
1.5
2.0
2.5
3.0
3.5
4.0
4.5


Fibrous roots 2020 (mg dw /g soil)
0.6
0.5
0.4
0.3
0.0
*
Untreated
Oxamyl





- ✓ Perennial peanut in row middles reduced sting nematodes by 94% compared to middles with native vegetation.
- ✓ Where weed incursion was noticeable in peanut plots, the nematode reduction was 85%.
- ✓ As in the nematicide trial the trees tended to be larger with more fibrous roots in treatments of peanut or oxamyl, but no significant effects.

- ✓ As trees and root systems grow the peanuts create row middles with abundant nitrogen.
- ✓ Full establishment requires time, but eventually very little weed management in row middle.

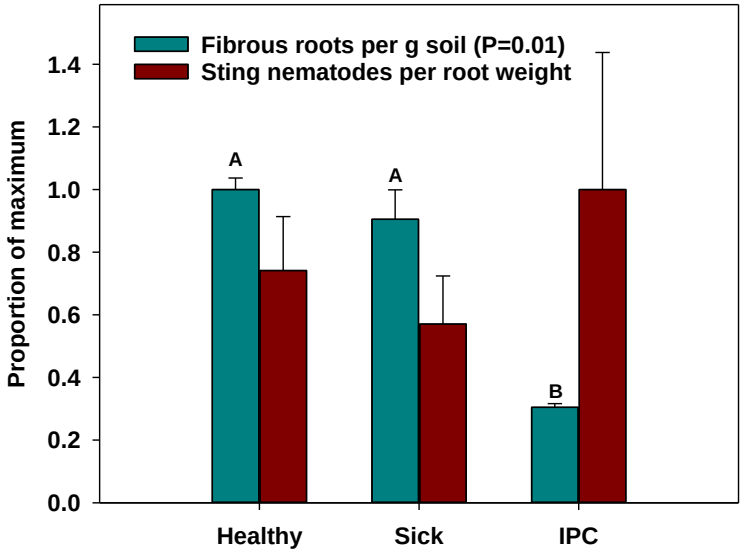
An IPC example - *young grove with heavy sting nematode infestation*

- ✓ Uncovered trees planted in fall 2017.
- ✓ Covered resets planted in summer 2019.
- ✓ Photo taken in fall 2020 (covered trees were half age of uncovered trees).

An example – *why do these covered trees exhibit no symptoms of sting nematode damage?*

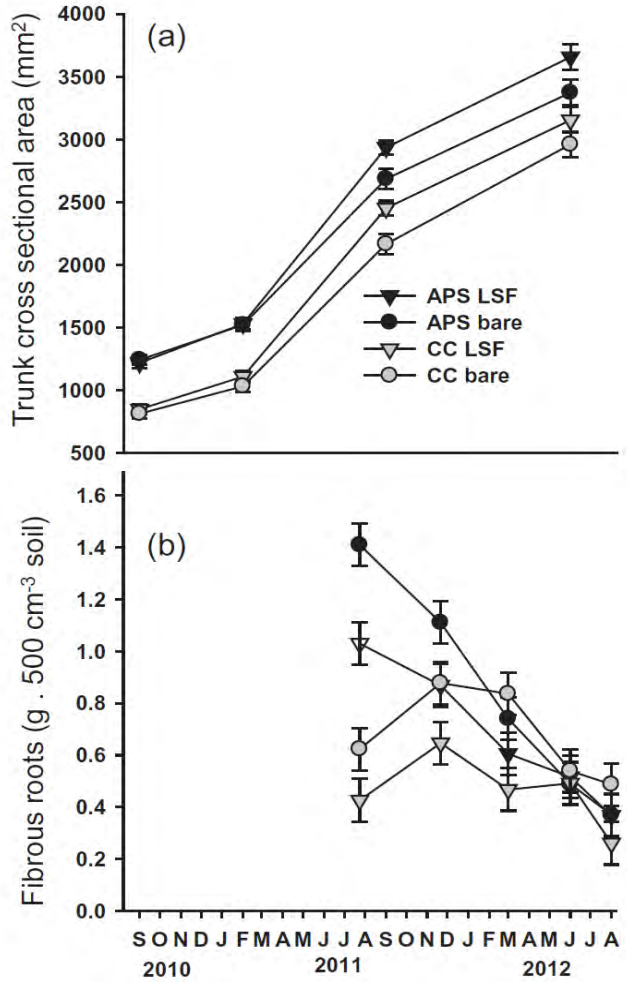
- ✓ Unlike uncovered trees, resets are HLB-free and not subject to root loss to the bacterium.
- ✓ Will nematode management increase health of covered trees more than that of uncovered trees? Is management even necessary?
- ✓ Following removal of protective covers, will nematode management of the larger trees be necessary, or more profitable than if trees were never covered?

I.e., *does increased tree development prior to contracting HLB confer greater tolerance of sting nematode?*



An example – *why do these covered trees exhibit no symptoms of sting nematode damage?*

- ✓ Trees with IPC had much larger canopies than older, unhealthy trees.
- ✓ Trees with IPC had fewer feeder roots that older, unhealthy or healthy trees.
- ✓ Trees with IPC <u>tolerated</u> levels of sting nematode comparable those on unhealthy trees.
- ✓ Root efficiency using <u>IPC</u> similar to that reported for rapidly growing trees <u>mulched with landscape fabric</u>.



Management to control citrus greening alters the soil food web and severity of a pest–disease complex

R. Campos-Herrera[a,b,*], F.E. El-Borai[a,c], T.E. Ebert[a], A. Schumann[a], L.W. Duncan[a]

Biological Control

Concluding messages

Physical barriers to pests and diseases such as CUPS, IPC, and landscape fabric mulch provide important protection against maladies other than HLB.

Greater plant development generally confers greater tolerance of pests and diseases. Physical barriers provide a means to delay the onset of some of the most serious of these.

The profitability of integrating barriers and other tactics such as following IPC use with targeted EPN applications or non-host cover crops merits research.

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