

Florida Citrus Under Protective Screen – From Research Prototype to Commercial Production

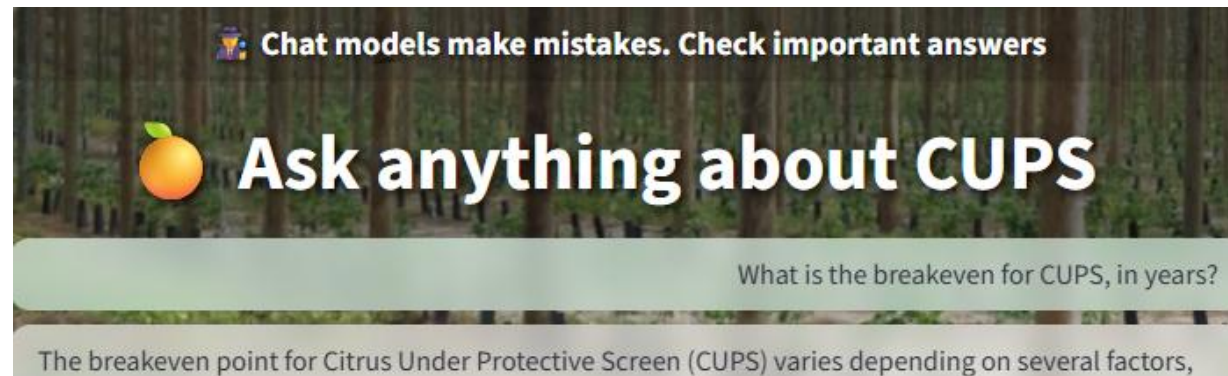
Arnold Schumann, Professor
UF/IFAS Citrus Research and Education Center
Lake Alfred
August 20, 2025

Take home messages

- The grapefruit in CREC CUPS produced 9,308 boxes/acre in 10 seasons, with yields exceeding those of pre-HLB Florida grapefruit
- Commercial CUPS is profitable and expanding: >1,500 acres in 2025
- Size and shape of CUPS influences the cost of construction
- Control of HLB, psyllids and other pests depends on effective spraying (coverage, targeting) and choice of screen mesh
- **CUPSchat** can answer questions about CUPS using an AI chatbot



CUPS seminar
08/07/2025



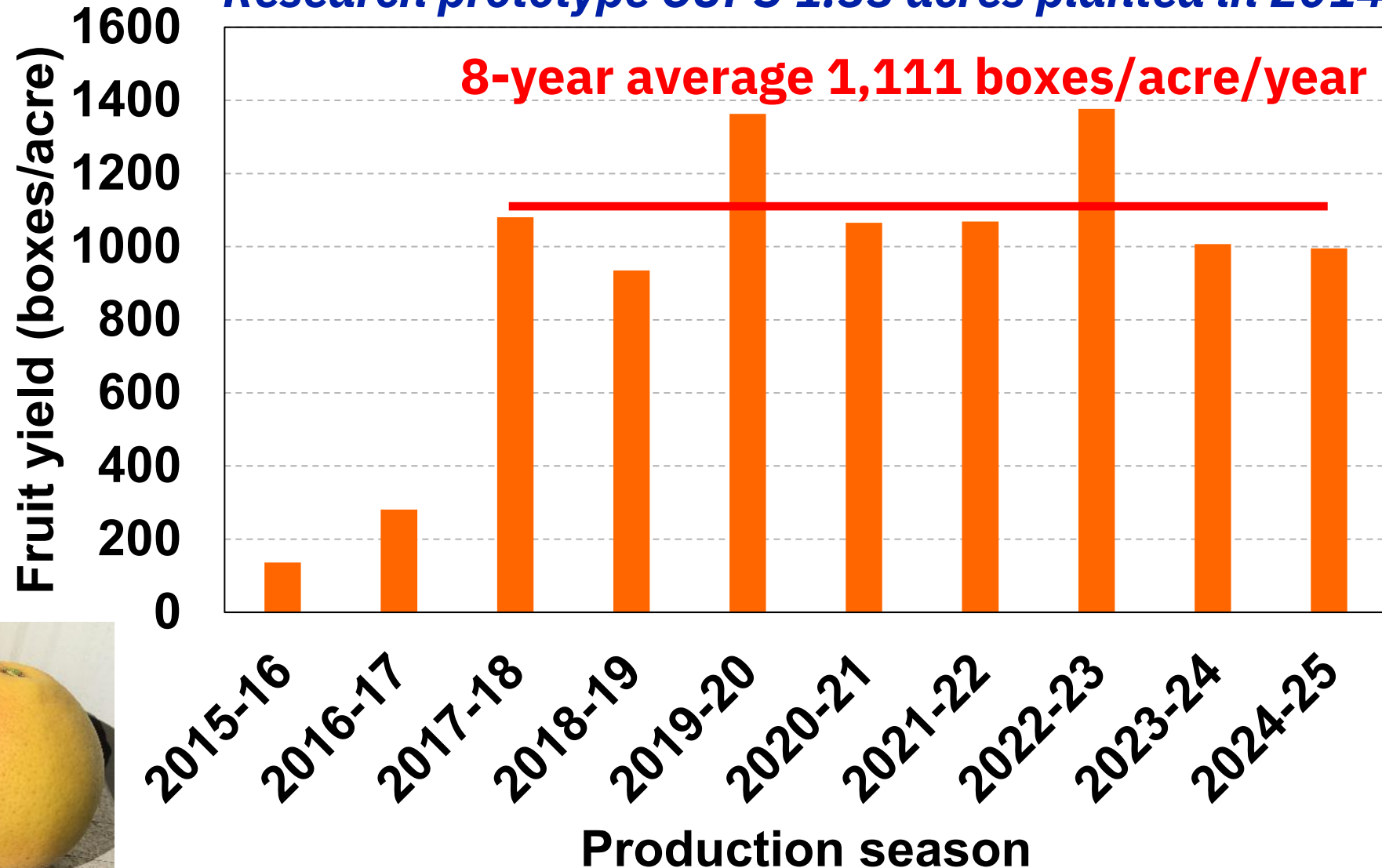
CUPSchat

Grapefruit yields from the research CUPS at the CREC

- Our best research result to date:
- 10 gal. pots 'Ray Ruby' / X639: **cumulative 9,308 boxes/acre** in 10 seasons
- 4' x 8' spacing = 1,361 trees/acre



Research prototype CUPS 1.33 acres planted in 2014



**CREC CUPS grapefruit: 7.5 years
\$20,000/acre/year (2021/22)**



Research CUPS: incentive for Commercialization

Commercial CUPS: June 2025; age 7 years; >800 boxes/acre/yr



Similar fruit revenue per year as *Research CUPS*

Commercial CUPS: June 2025; age 0.2 years; 240 acres



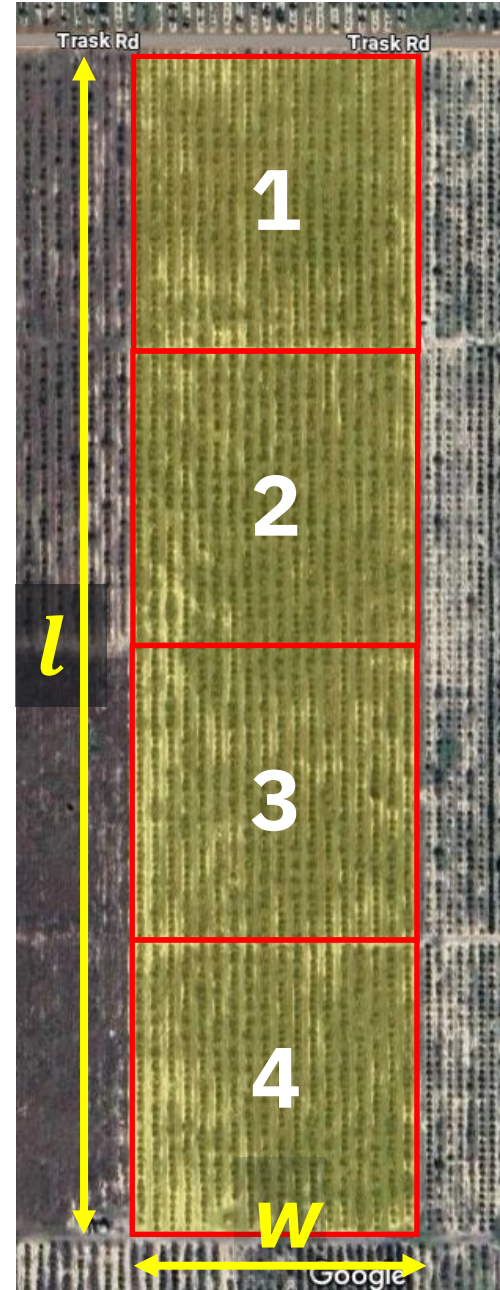
Expect full production at age 2.5 years

Tips for designing CUPS structures

- Existing citrus block: 2,607' x 634' ~38 acres
- 4.1 : 1 ratio of length : width
- Is it better to build one large elongated CUPS or four smaller square CUPS structures?
- As the size of the CUPS increases, the construction cost per acre decreases because the perimeter increases at a slower rate than the area
- As the **length : width ratio** increases, the cost of constructions increases. A square (1:1) is the shape with lowest cost

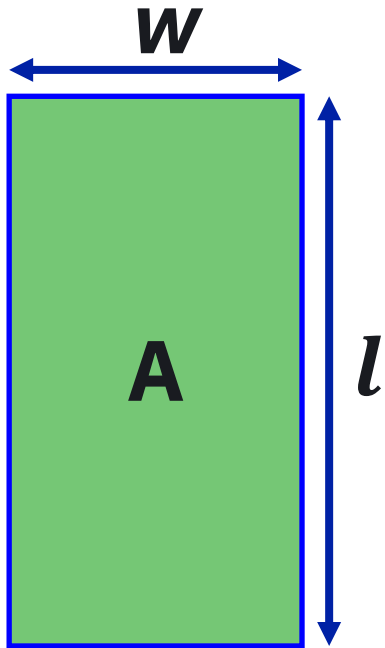


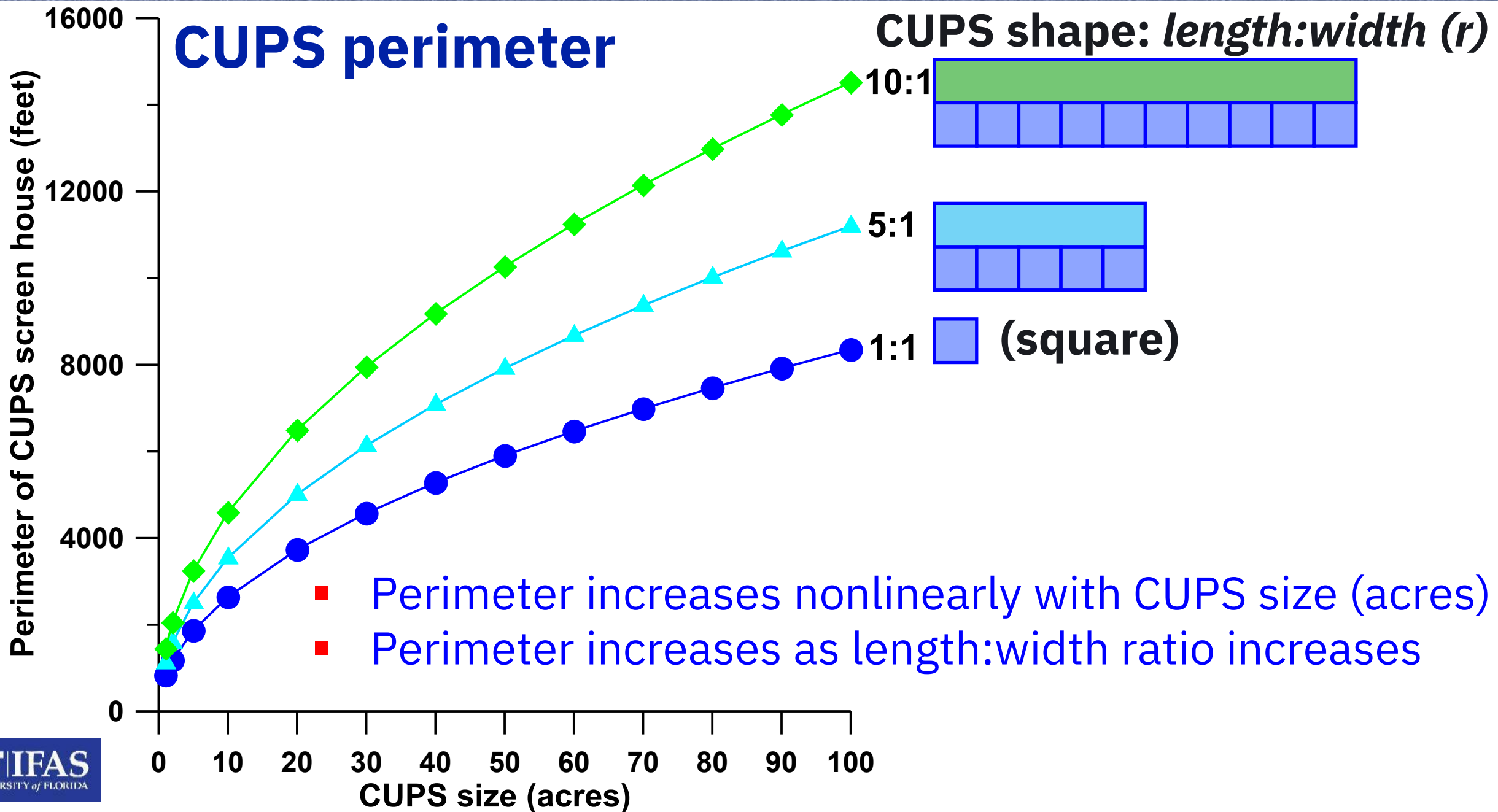
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CUPS perimeter & area

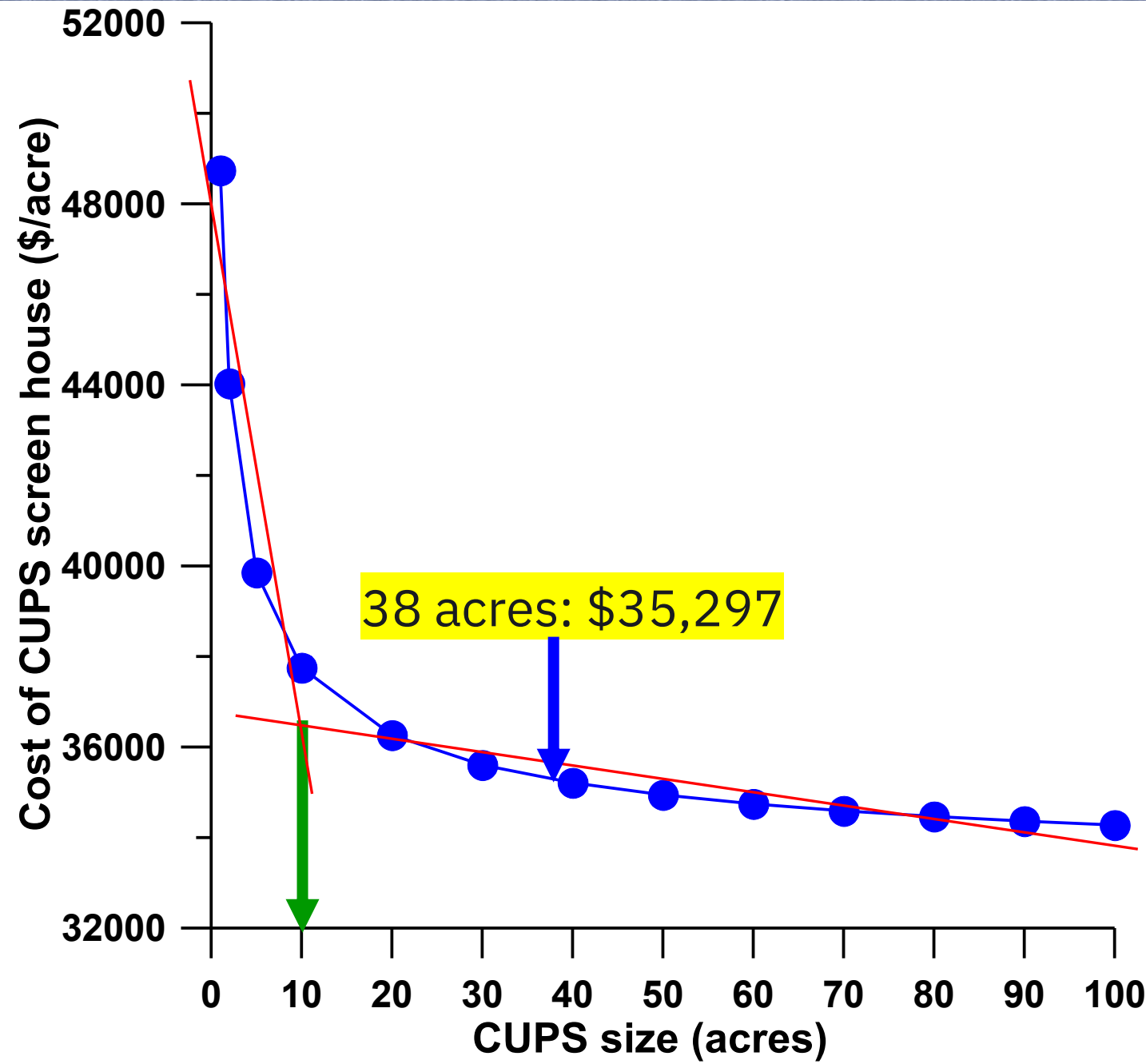
- Perimeter (P) = $2l + 2w$
- Area (A) = $l \times w$
- Shape ratio (r) = $\frac{l}{w}$





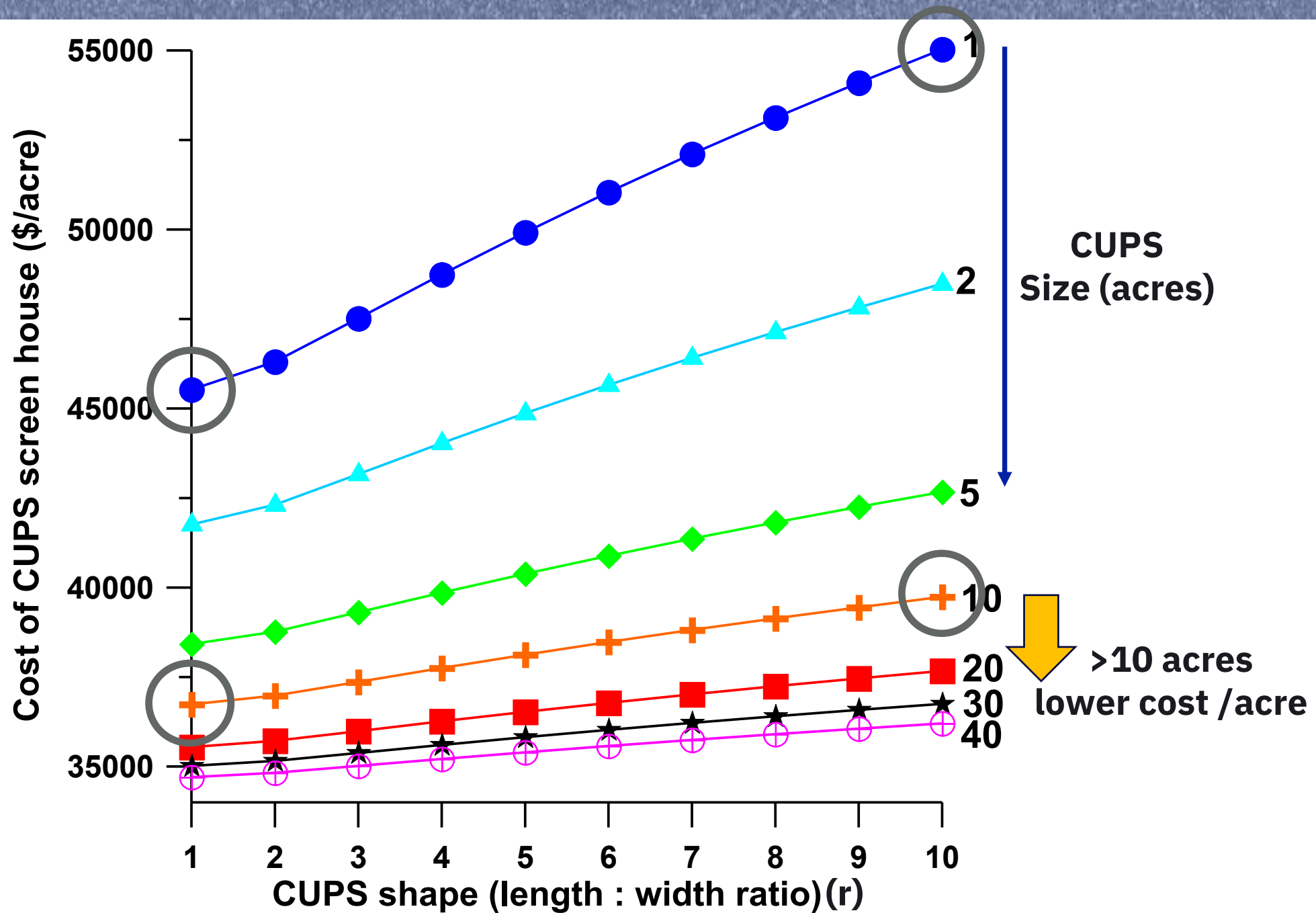
CUPS cost calculation

- Existing citrus block: 2,607' x 634' ~38 acres; **4.1 : 1 ratio**
- Roof cost per acre is constant: \$0.75/sq. ft. x 43,560 sq. ft. = \$32,670
- Wall cost per acre: \$1.1/sq. ft. x perimeter (6,482 ft) x wall height (14 ft) / 38 acres = \$2,627
- Total cost per acre = roof cost + wall cost = \$35,297
- CUPS size >10 acres best**



CUPS cost/acre for shape & size

- 1:10 shape:
10 acres = **28%**
lower cost than
1 acre
- 1:1 shape:
10 acres = **19%**
lower cost than
1 acre

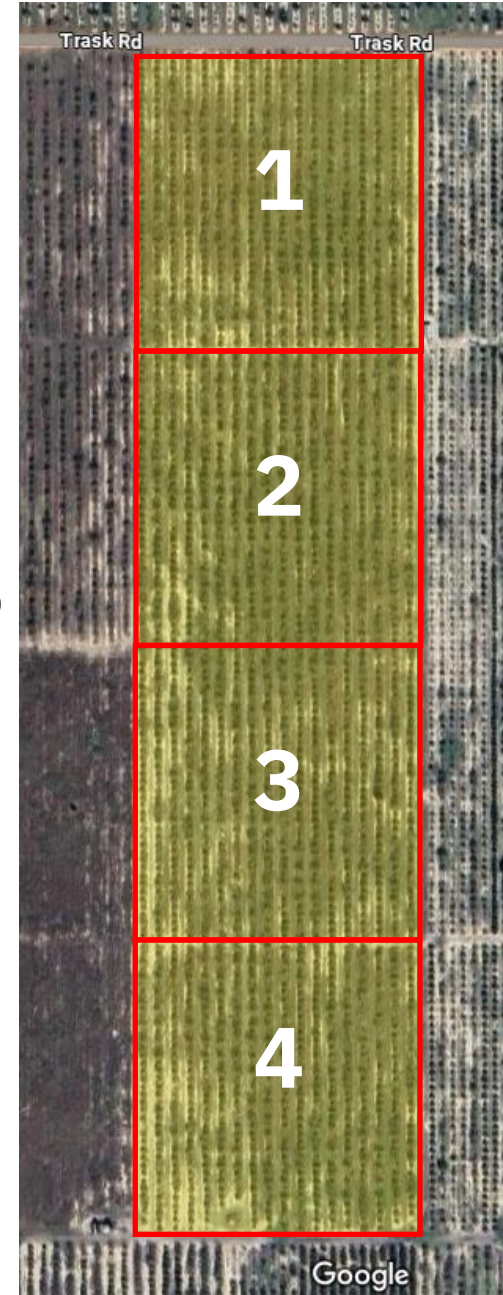


A single large CUPS or 4 smaller CUPS?

- Existing citrus block: 2,607' x 634' ~38 acres
- Single CUPS of 38 acres = **\$35,297/acre**
- Four CUPS of 9.5 acres each = **\$36,841/acre**
- The four square CUPS cost **4.2% more (+\$58,672)** than the single large 38-acre CUPS
- Cost estimates don't include additional doors, buffers between structures, accessories
- There are cost – benefit factors to consider. The more expensive four individual CUPS can be better managed for pests and diseases, storm damage can be isolated, pest invasions quarantined, and cross-pollination prevented



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Screen for psyllid exclusion

40-mesh



50-mesh



- Minimum HDPE screen size is 40-50 mesh*, 80% visible light transmission
- 50-mesh is stronger than 40-mesh but reduces airflow

Ebert T.A., Waldo L., Stanton D., Schumann A. (2020) Screen Mesh Size for Exclusion of *Diaphorina citri* (Hemiptera: Liviidae) in Citrus Production. Journal of Economic Entomology <https://doi.org/10.1093/jee/toaa095>

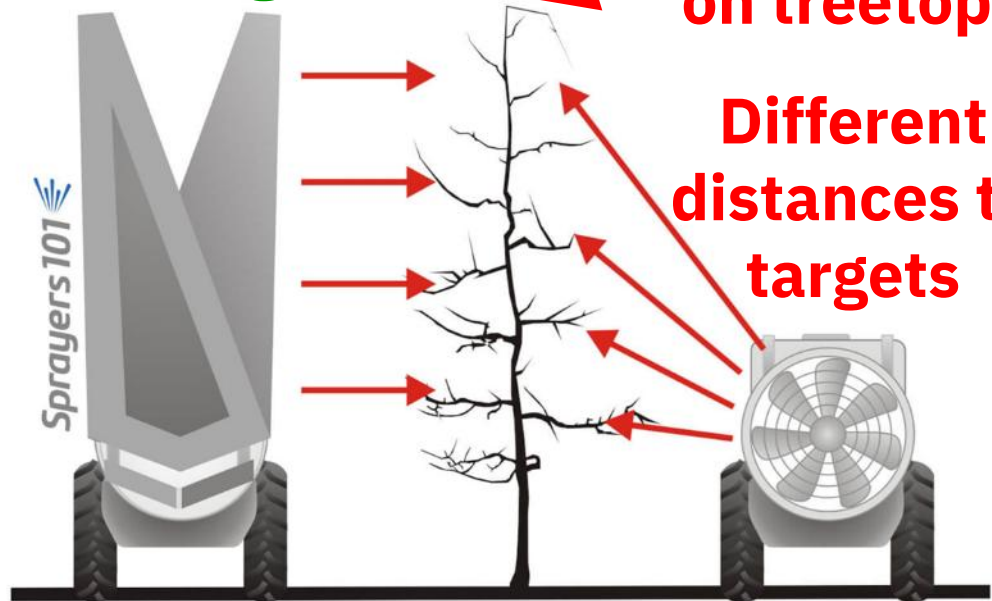
Effective pest spraying in CUPS

- CUPS planting densities are higher ~360 trees/acre than in conventional citrus groves
- The closely spaced tree rows (e.g. 15') make it difficult to target treetops with airblast sprayers
- Treetops can be refuges for pests, including psyllids
- Escaped pests can develop pesticide resistance
- Spray a CUPS within one day



Grove & sprayer geometry

Good coverage

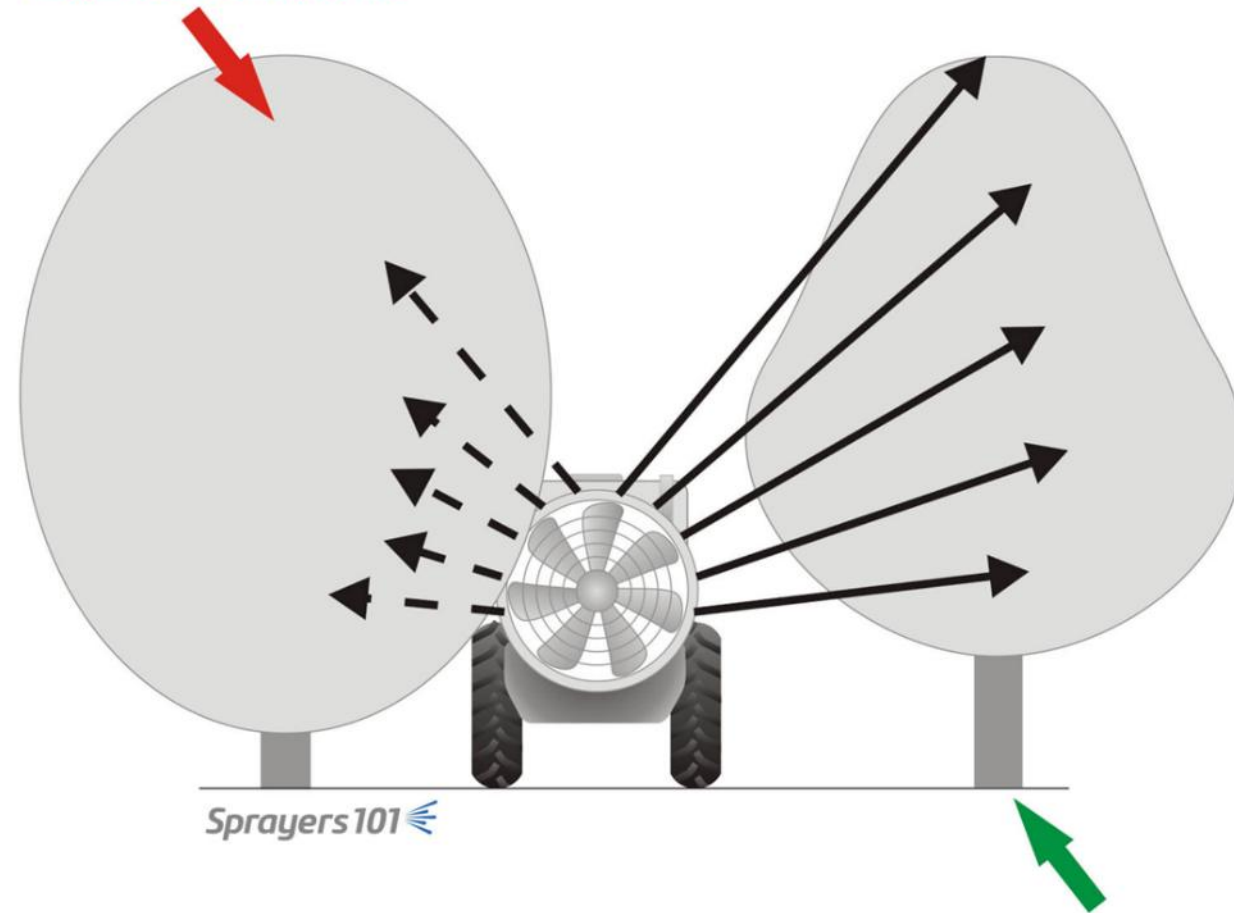


Sprays between branches

Sprays through branches

Closed canopy, top of tree blocked by lower limbs, crowded alley:

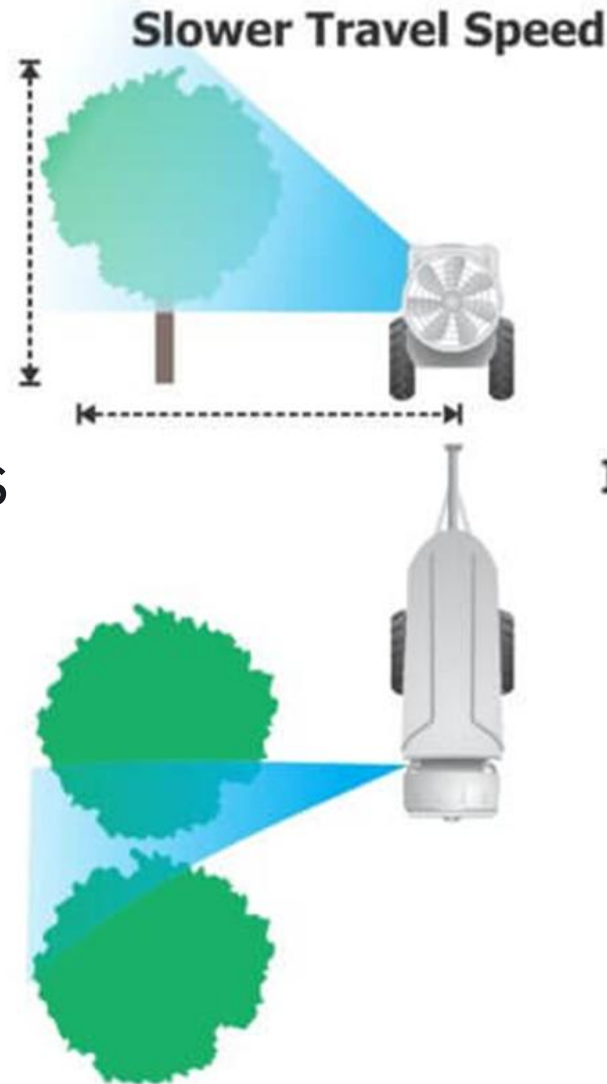
BAD COVERAGE



Open canopy, top of tree not blocked by lower limbs, good alley clearance:
GOOD COVERAGE

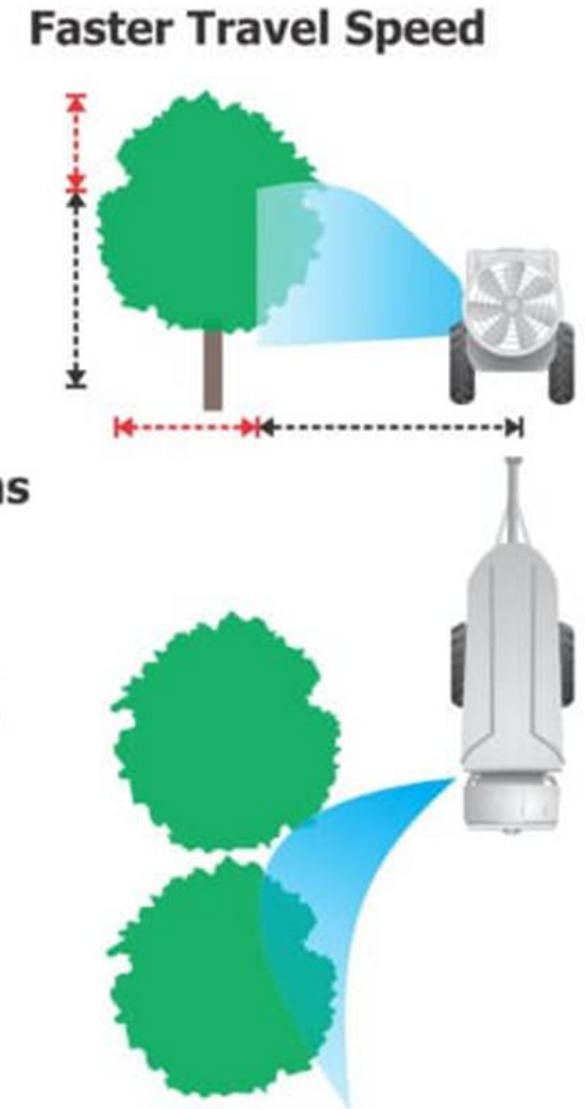
Slower travel speeds improve spray coverage

- Compare spray coverage using water-sensitive paper in the trees at different speeds



Increasing dwell time means more penetrating power.

That's a longer throw and depending on the sprayer, a higher spray height.



Source: Sprayers 101

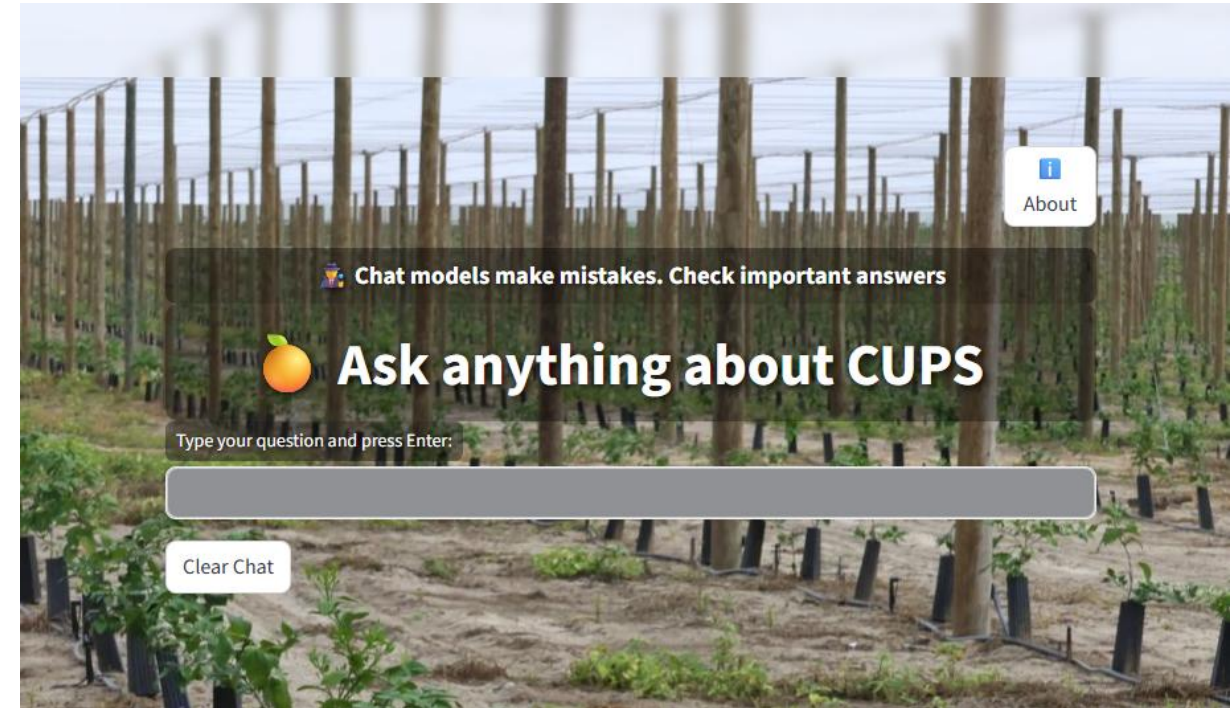
***CUPSchat*: a modern artificial intelligence tool for extension**

<https://citrusdiagnosis.ifas.ufl.edu/CUPSchat/>



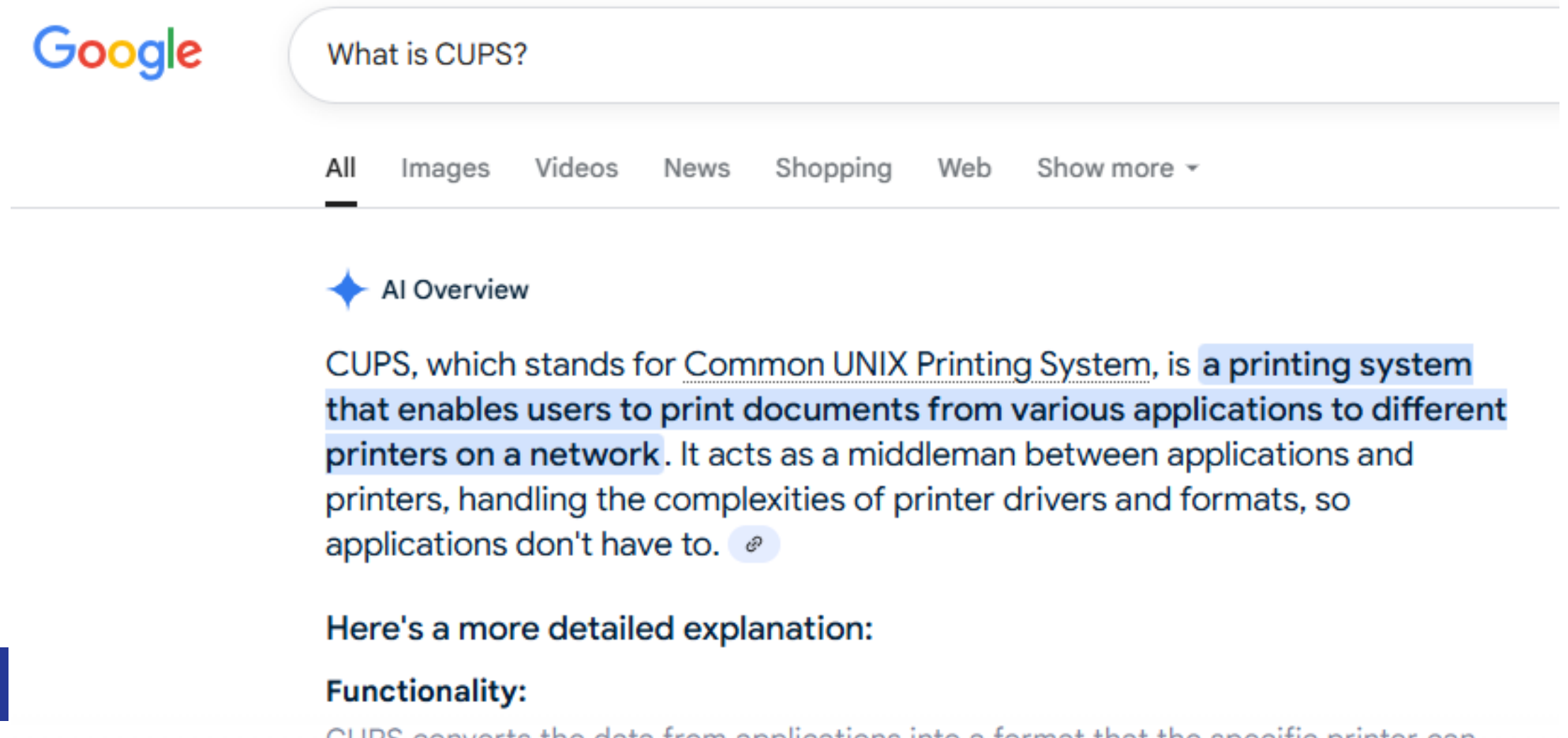
What is CUPSchat?

- Pools 11 years of knowledge about CUPS from >70 documents (2025)
- Can be continuously updated with new information
- Collates and interpolates information, including data collected over time in different documents
- Use with discretion – like any chatbot



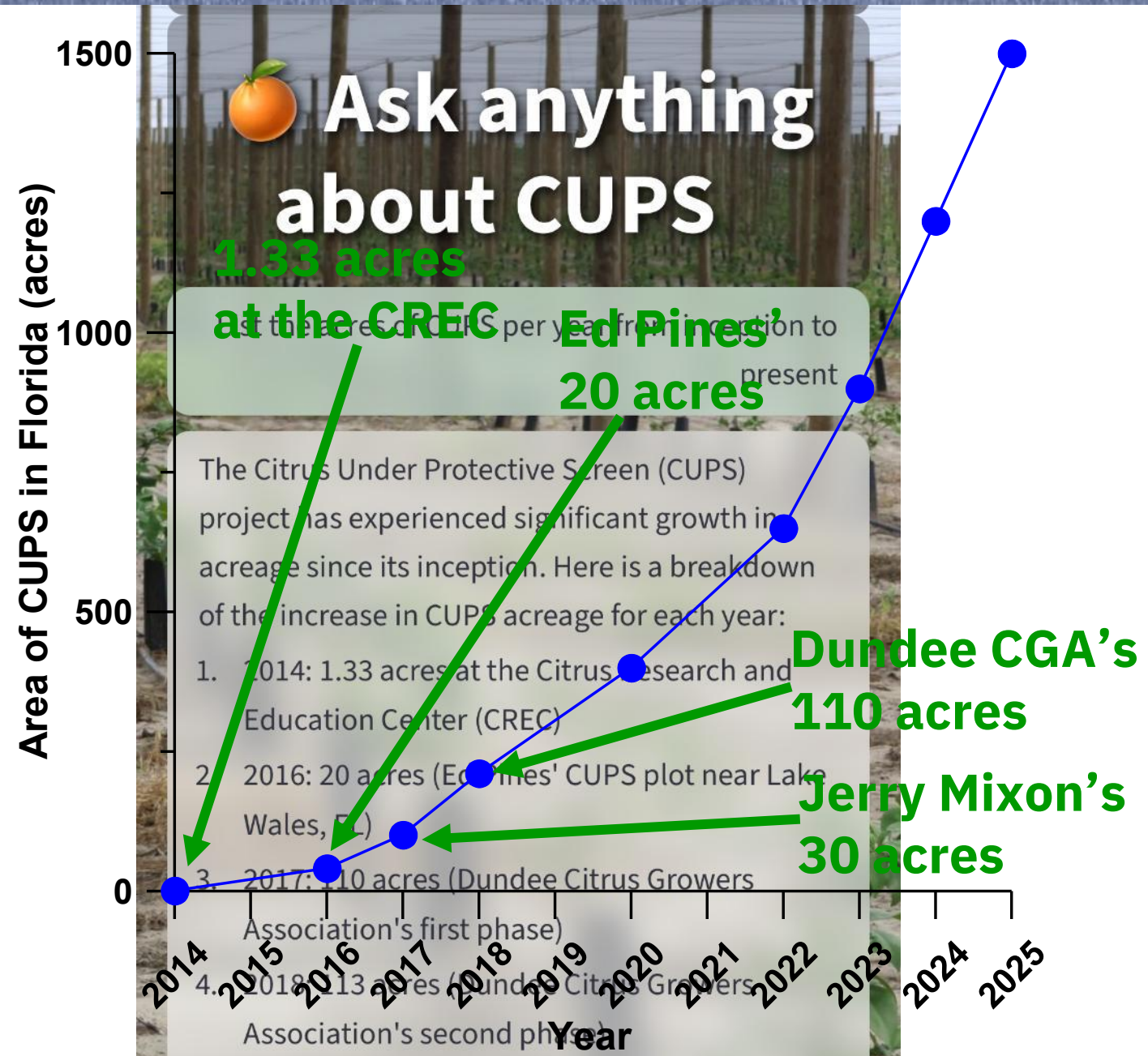
CUPSchat: a modern artificial intelligence tool for extension

- Mainstream search engines and AI chatbots don't know CUPS



CUPSchat answers

- **PROMPT:** List the acres of CUPS per year from inception to present.
- **Answer:** The CUPS project has experienced significant growth in acreage since its inception. Here's a breakdown of the increase in CUPS acreage for each year:



***CUPSchat* answers**

- **PROMPT:** What is the breakeven for CUPS, in years. Be concise but show sources of information
- **Answer:** The breakeven point for Citrus Under Protective Screen (CUPS) is ***around 7-8 years***. This is based on various studies and reports, including...

Including... A study by Arnold Schumann, a professor at the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS), found that the breakeven point for CUPS is around 7-8 years, with an initial investment cost of around \$43,000 per acre.
CUPS Expensive but Beneficial - CUPS Specialty Crop Grower.pdf

. Another report by the University of Florida Institute of Food and Agricultural Sciences (UF/IFAS) estimated that the breakeven point for CUPS is around 7 years, with an initial investment cost of around \$1 per square foot (\$43,560 per acre).
Return-on-Investment Potential of CUPS - Citrus Industry Magazine.pdf

. A report by the Irrigation Association (IA) noted that the breakeven point for CUPS is around 7-10 years, depending on factors such as tree density, variety, and market prices.
CUPS works to protect citrus trees - Irrigation Today.pdf

. Overall, the breakeven point for CUPS is generally estimated to be around 7-10 years, depending on various factors such as initial investment costs, tree yields, and market prices.

Conclusions

- Design factors that determine the cost of a CUPS are shape and size; costs per acre are less with larger, more square-shaped CUPS
- 10 acres is a sweet spot for CUPS size based on costs of construction
- Plantable space inside CUPS must also be calculated
- Insure CUPS structures & make preparations for storm damage repairs
- **CUPSchat** is a CUPS-specific AI tool that can help growers, extension agents and researchers obtain instant answers and reports from 11 years of CUPS knowledge
- Chatbot performance is improved with well-crafted prompts
- Verify chatbot answers for mission-critical questions



THANK YOU

Grower stakeholders & cooperators

UF/IFAS Extension Agents

Laboratory and Support Staff

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UF/IFAS Citrus Initiative

USDA/ECDRE

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CUPS seminar
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CUPSchat



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