

Zinkicide™ - a systemic nano-ZnO based bactericide/fungicide for crop protection

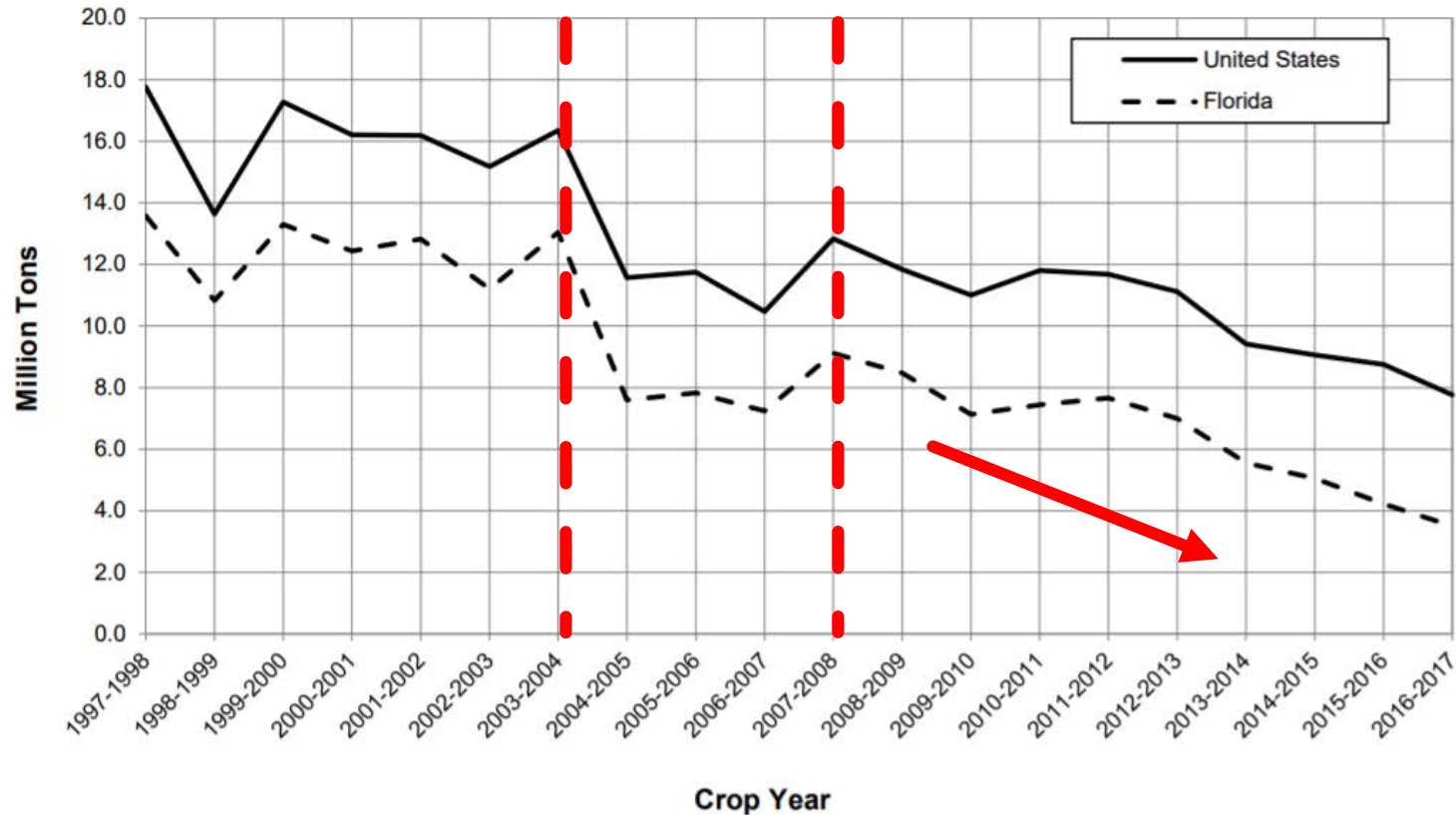
Swadeshmukul Santra

QEEN II: 2nd Quantifying Exposure to Engineered Nanomaterials
from Manufactured Products Workshop

Washington D.C.
October 10-11, 2018

Citrus Production in Florida

Citrus Production – United States and Florida: Crop Years 1997-1998 through 2016-2017



More than 50% reduction on citrus production in the last 10 years.



9M tons,
2008



<4M
tons,
2017

Source: Florida Citrus Statistics 2016-2017 (March 2018) USDA, National Agricultural Statistics Service.

Citrus Greening (HLB)

- ▶ Huanglongbing (HLB) is a deadly bacterial disease.
- ▶ Main symptoms include reduction on fruit size and intense fruit drop.
- ▶ It is caused by the phloem-limited bacterium '*Candidatus Liberibacter asiaticus*' (CLas).
- ▶ Transportation of sugar from leaves to plants parts is compromised by the presence of CLas in the phloem tissue.
- ▶ CLas bacteria are vectored by the Asian citrus psyllid (ACP: *Diaphorina citri*).



Source: USDA
- Agricultural
Research
Service



Asian Citrus Psyllid (ACP)

- ▶ *Diaphorina citri* is a 4 mm sap-sucking bug that feeds on plants, using their sucking and piercing mouthparts.
- ▶ CLas multiplies inside the insect's gut and is transmitted from tree to tree.
- ▶ Eggs are laid (800/life time of female) on the tips of growing shoots, between and near the unfolding leaves.



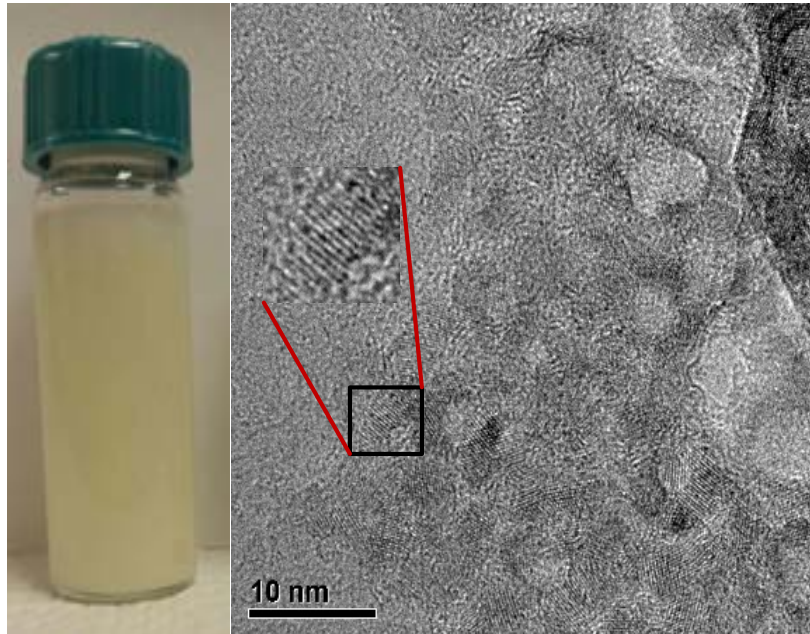
A systemic bactericide
capable of reaching phloem
tissue is desperately needed!

Zinkicide™

<https://www.zinkicide.org/>

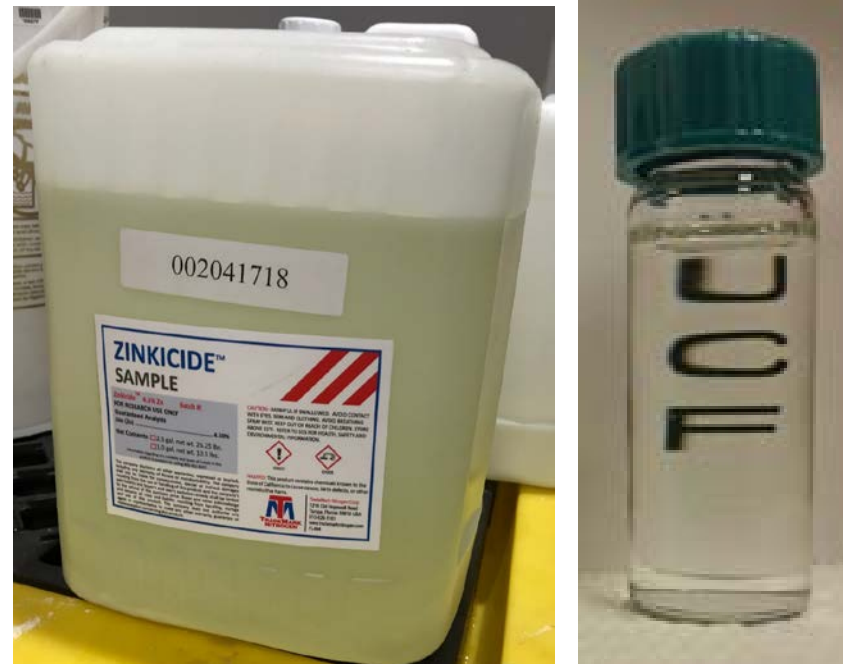
Zinkicide - Reagent to Ag grade materials

Reagent grade



- ▶ <10 nm particles
- ▶ Stability - Slowly settles

Agricultural grade - 110th attempt



- ▶ ~4 nm particles
- ▶ Stability - No settlement
- ▶ In proper storage container

Potential of Nano-Formulated Zinc Oxide for Control of Citrus Canker on Grapefruit Trees, J. H. Graham, E. G. Johnson, M. E. Myers, M. Young, P. Rajasekaran, S. Das, and S. Santra, Plant Disease 2016 100:12, 2442-2447

Zinkicide™ - HLB Field Trial

Two separate HLB Field trials

- ▶ **Grapefruit** - 6 year old trees in Indian River,
- ▶ Randomized design with 25 trees in 5 plots
- ▶ Spray only, drench only, spray+drench
- ▶ Multiple rates

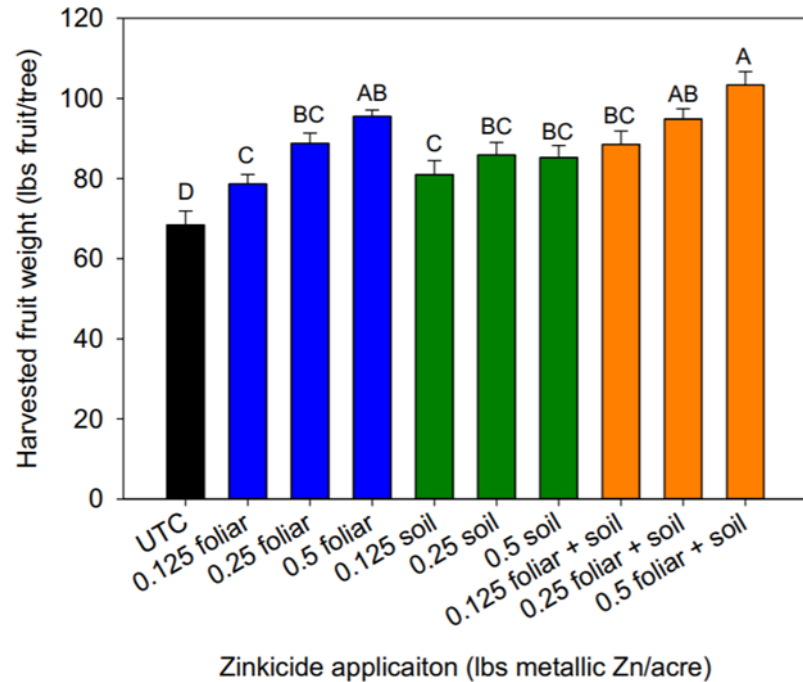
- ▶ **Valencia** - 20+ year old trees on Ridge,
- ▶ Randomized complete block design
- ▶ 2 rates for spray only, 1 rate for drench and spray+drench
- ▶ Yield, fruit size, and juice quality assessed at harvest



Yield Response - dose dependent

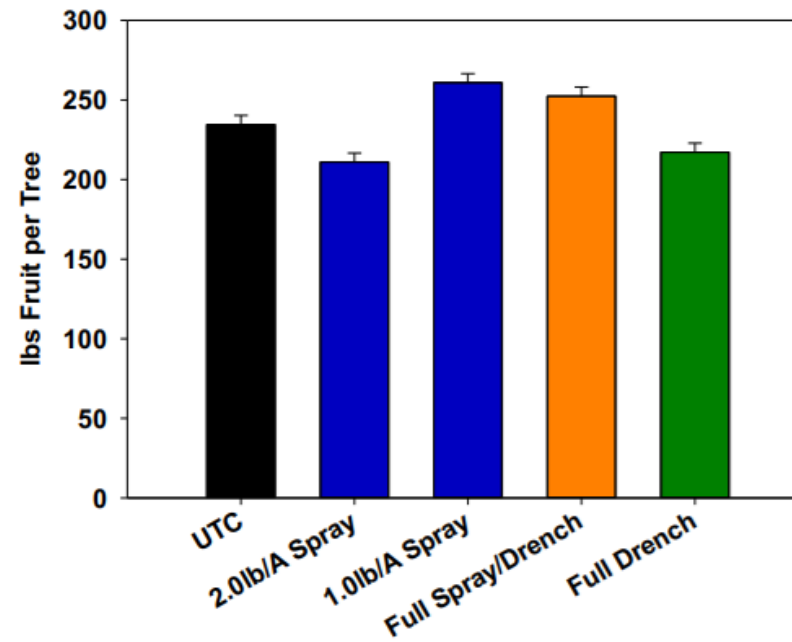
Grapefruit

► Harvested 2017



Valencia

► Harvested 2018

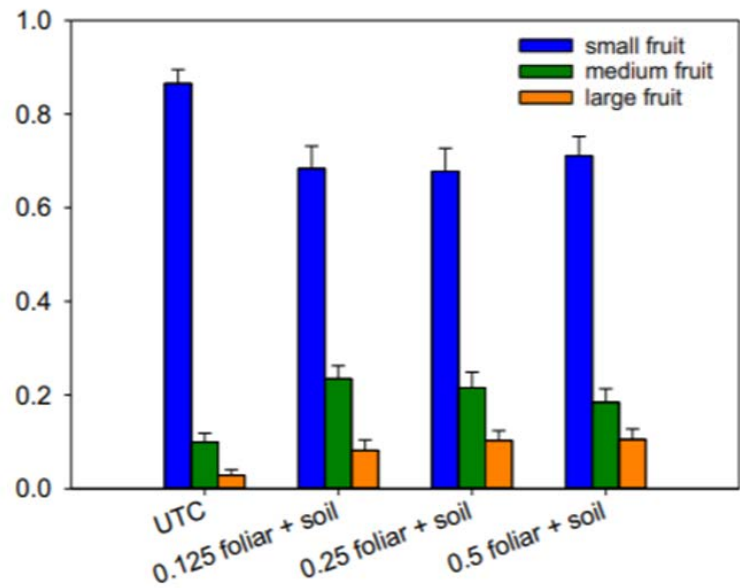


Acknowledge to
Dr. Evan Johnson
University of
Florida/Lake Alfred

Fruit size and juice quality

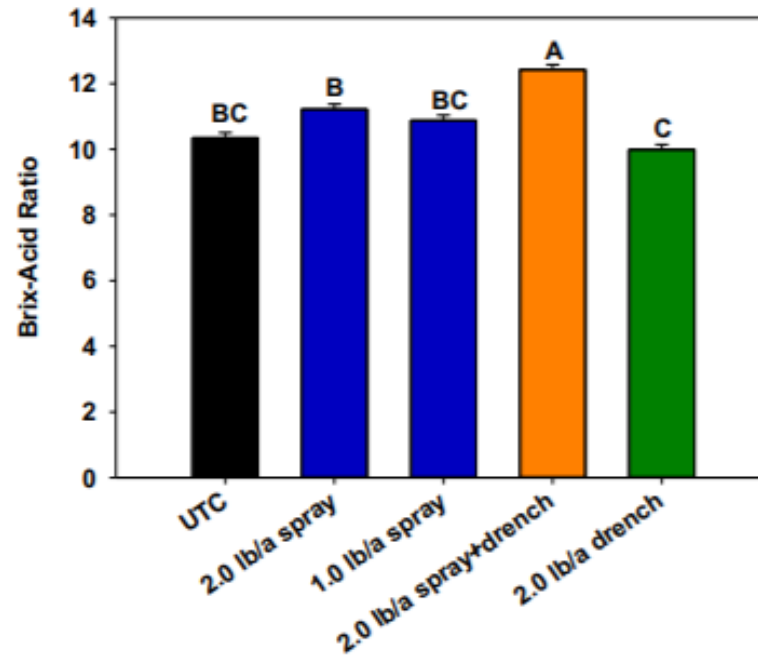
► Grapefruit

Dose dependent fruit size effect



► Valencia

Dose and application method dependent juice quality effect



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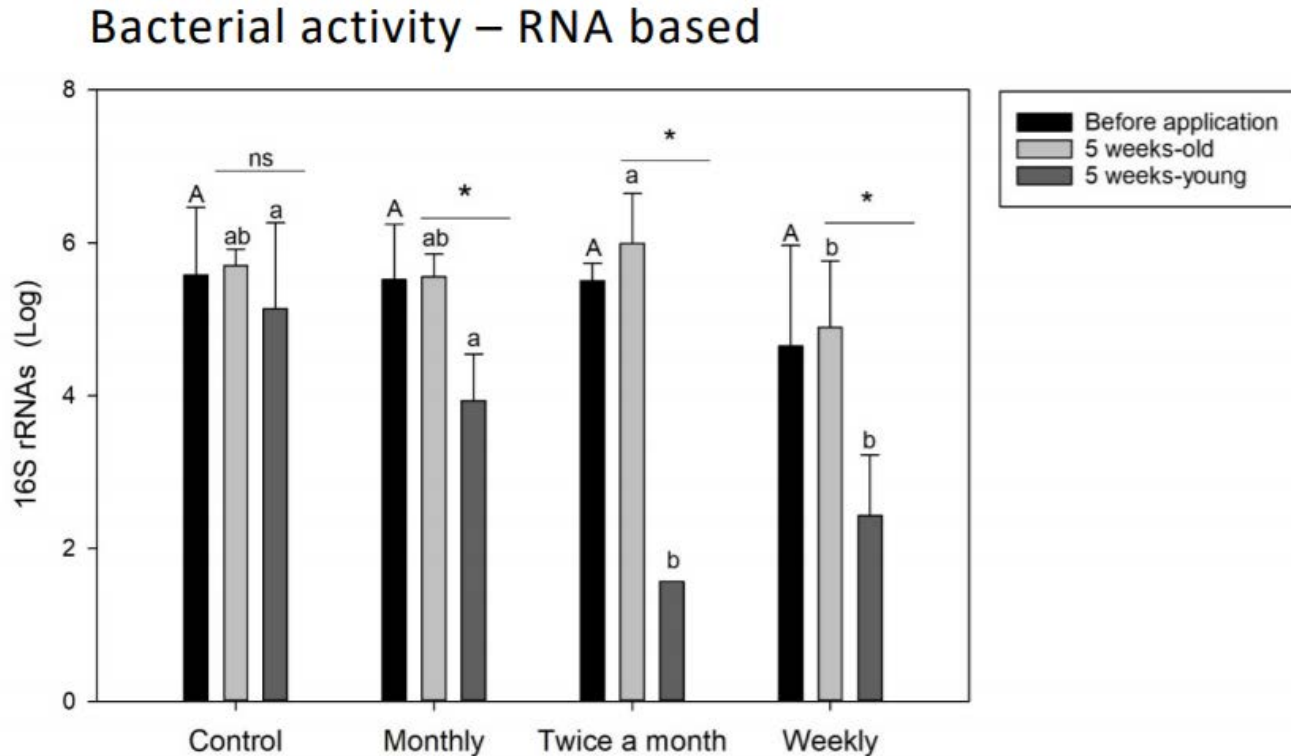
Zinkicide reduced hurricane damage in young trees

- ▶ New planting trial - Ft. Pierce
 - ▶ Trees treated monthly since planting
 - ▶ Originally with SG4, 2017 with fixed ag-grade formulation
- ▶ Spray + Drench Zinkicide treatment kept majority of leaves and fruit
- ▶ Most other trees stripped of leaves, some of fruit



Zinkicide™ Antibacterial efficacy

Bacterial activity- RNA



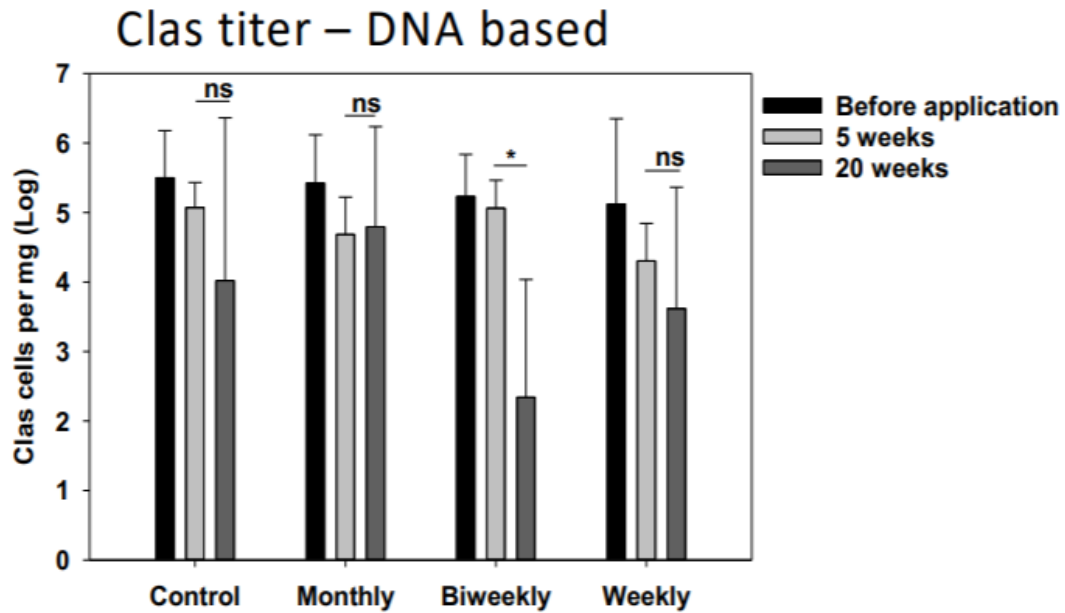
- ▶ Greenhouse experiment
- ▶ Effect of Zinkicide rate: monthly, biweekly and weekly applications
- ▶ RNA activity reduced in young leaves
- ▶ RNA activity in new growth predicts bacterial titer reductions
- ▶ Biweekly application is most effective

Acknowledge to
Dr. Mayara Murata
University of
Florida/Lake Alfred

Zinkicide™ Antibacterial efficacy - DNA

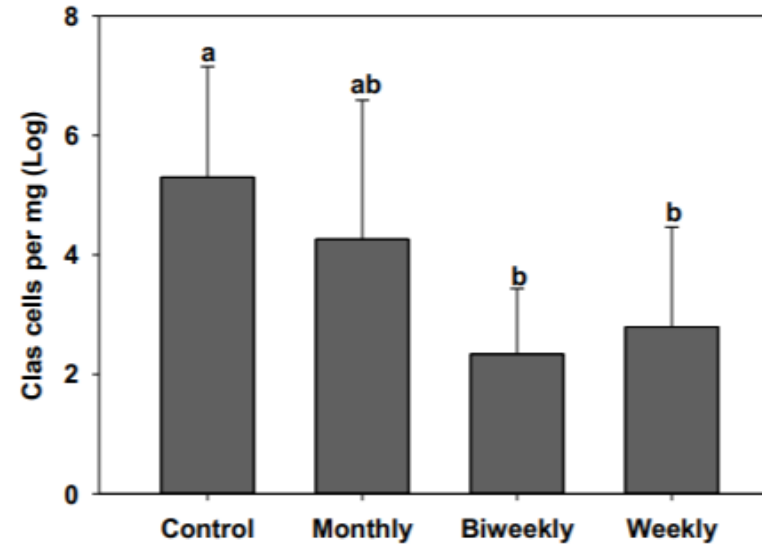
► Old leaves

1000-fold reduction in bacterial titer after 20 weeks of biweekly application



► Young leaves (after 20 weeks)

Experiment is being repeated and titer reduction has been observed after 5 weeks in young leaves.



Acknowledge to
Dr. Mayara Murata
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Registration Status

- ▶ Zinc and Zinc oxide are not registered as actives for any pesticide use
- ▶ Full registration requires a Registrant (Ag-chem company)
 - ▶ Original registrant backed out when couldn't get a "me too" registration (existing active)
 - ▶ Final negotiations underway for new registrant
- ▶ Full registration process (GLP certified lab testing)
 - ▶ Toxicology
 - ▶ Residue
 - ▶ Environmental Fate

Registration Status - Prelim Data

- ▶ Not GLP certified
- ▶ Toxicology
 - ▶ Adult Honeybees not affected by Zinkicide
 - ▶ Honeybee larva sensitive to feeding on rates 10 times in field rate
 - ▶ Less toxic to aquatic animals (Fathead minnow larvae) than commercial copper products
- ▶ Residue
 - ▶ No significant increase in Zinc content of juice or peel oil
 - ▶ Preliminary evidence from greenhouse trials suggests efficacy lost after ~7 days

Conclusions

- ▶ Zinkicide has systemic activity
- ▶ Zinkicide can improve yield on HLB-affected trees
- ▶ Zinkicide application rate and timing affect the efficacy
- ▶ Agricultural-grade formulation is ready for EPA registration
- ▶ Bee toxicity and residual analysis of Zinkicide are being studied



Acknowledgments

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Dr. Johnson (UF)
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“Authors acknowledge the UCF Materials Innovation and Sustainable Agriculture Center for facilities and technical support.”

Thank you!

The background features abstract, overlapping geometric shapes in various shades of green, ranging from light lime to dark forest green. These shapes are primarily located on the right side of the frame, creating a modern, layered effect against the white background.