Plant Essential Oil – Effective or not?

Evaluating Fungal Disease Management in organic Blueberry production

Wardatou Boukari*, Yuru Chang, Christ Mane Belizaire, Ali Sarkhosh,

Jeffrey K. Brecht, and Philip Harmon

Plant Pathology and Horticultural Sciences Departments

University of Florida

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- Organic Agriculture Research and Extension Initiative (OREI), agency project ID 2020-51300-32181
- "Plant safety, horticultural benefits, and disease efficacy of essential oils for use in organically grown fruit crops: from the farm to the consumer" PI: Ali Sarkhosh (UF-Gainesville)
- **Multistate:** FL, CA, HI, GA, SC
- **Multi-crop:** Targets common pre- and post-harvest diseases in peach, blueberry, mango and avocado

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Fruits and vegetables for Florida and beyond

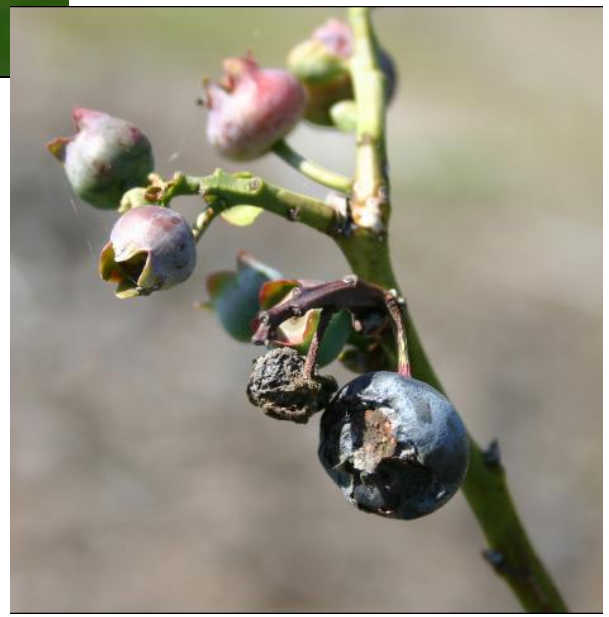
PLANT PATHOLOGY

- Fruit crop production is constantly challenged by plant diseases:
  - Throughout the growing season, at harvest and post-harvest (all the way to the consumer table)

Photo Credit: Phil Harmon, UF/IFAS

Rust

Blossom blight & Gray mold



Septoria spots

❑ Plant essential oils (EOs):

- ❑ Broad-spectrum activity against plant pathogens , and soft-bodied arthropod pests.
- ❑ Have no negative environmental impact.
- ❑ Safe for human consumption.
  - ❑ Used in organic farming as alternative to synthetic materials.
  - ❑ Also available for use in conventional agriculture.

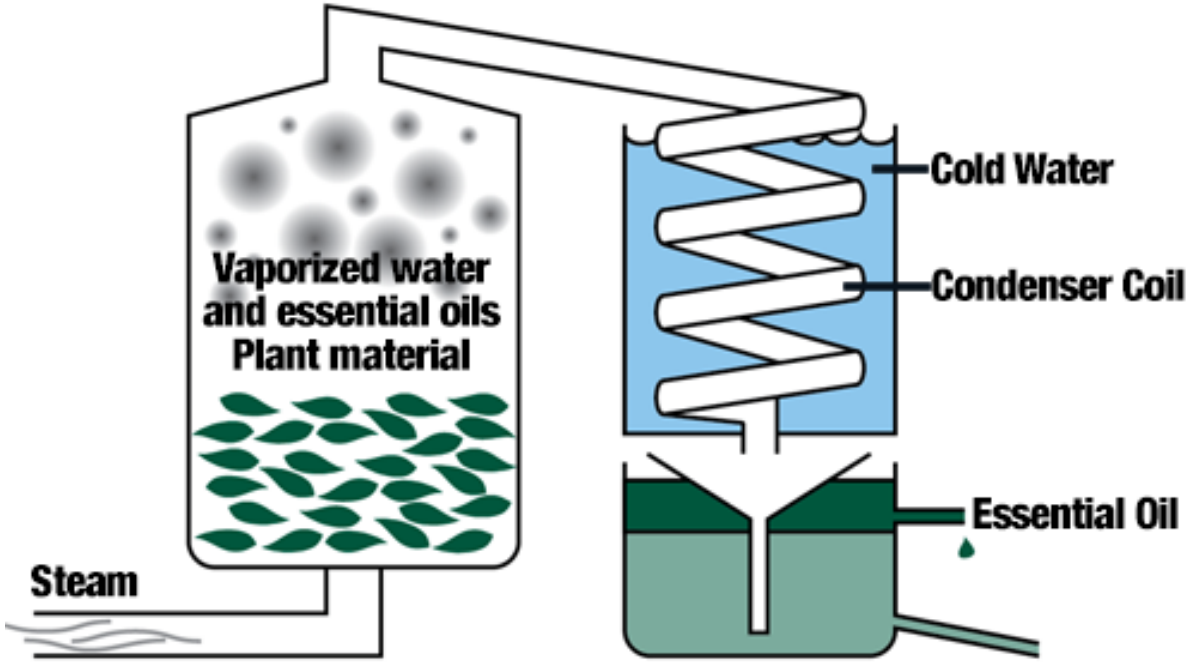
Type	Materials [FRAC group]	Organic Use
Synthetic	Fluopyran [7], Cyprodinil [9], Azoxystrobin [11], Fludioxonil [12]	No
Synthetic	Metallic copper [M01]	Yes*
Natural	**Essential oils [BM01]**	**Yes**
Biological	*Bacillus* spp. [BM02]	Yes

EOs are complex mixtures of substances made by plants

Savory

Oregano

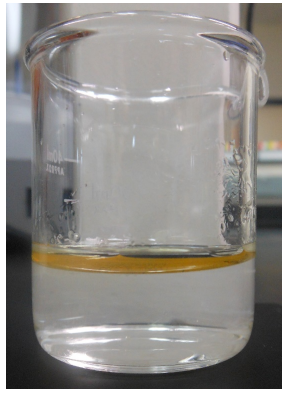
Thyme



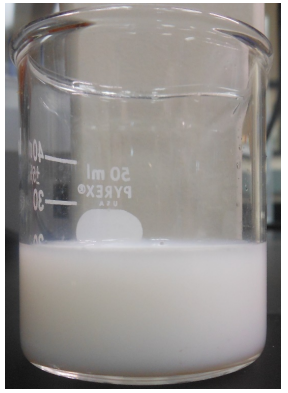
(Illustration credits: GloryBee)

Commercial formulations* facilitate mixing of essential oil into water

Pure EO



\+ Inert ingredients =



Proprietary biopesticide formulation

OMRI LISTED® For Organic Use

Trade name [Company]	Claim
Aleo™[Brandt Consolidated, Inc.]	Fungicide, Bactericide
Biomite™ [Natural Plant Protection]	Miticide
Cinnerate [Sym Agro]	Fungicide, Miticide, Insecticide
EF400™ [USAgriTech, Inc.]	Fungicide
Gargoil®[Westbridge Ltd.]	Fungicide, Insecticide
Green Furrow™ Bac-Stop [MarVista Resources]	Fungicide, Bactericide
Mevalone®[K&NE Earth Matters]	Fungicide against *B. cinerea*
Reckoning [GroPro]	Fungicide
Sporan®EC^2 [KeyPlex]	Fungicide
ThymeGuard®[Agro Research Int.]	Fungicide, Bactericide, Insecticide
Thymox®[Laboratoire M2]	Fungicide, Bactericide, Insecticide
Timorex Act®[Summit Agro, USA]	Fungicide
Trilogy®[Certis USA LLC]	Fungicide
Weed Slayer®[Agro Research Int.]	Herbicide
Zayin® [Certis USA LLC]	Fungicide

*Always read and follow the product's label and make sure the product is intended for your specific use

Research Question

What is the efficacy of EOs to control fungal diseases of blueberry?

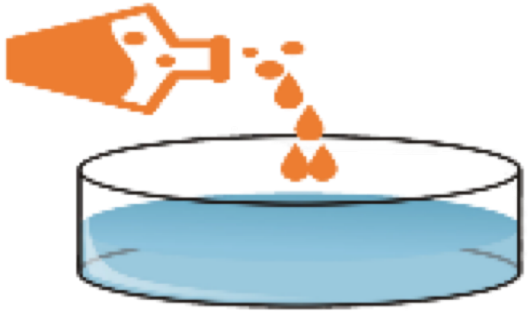
Phases

1 – In vitro assays

Pure EO & EO-based biopesticides:

- Thyme/Oregano/Savory oils
- Thyme oil (Thyme Guard®)
- Tea tree oil (TIMOREX ACT®)

Each product was added to culture media (PDA), so the pathogen is in direct contact with each essential oil at a desired concentration



Timorex Act (Tea tree oil)

Thyme oil

Savory oil

Thyme Guard (Thyme oil)

Oregano oil

Anthracnose

Credits: M. Velez-Clement, UF & Bill Cline, NC State

Tested 10 fungal isolates

Target spot

Credit: Phil Harmon, UF/IFAS

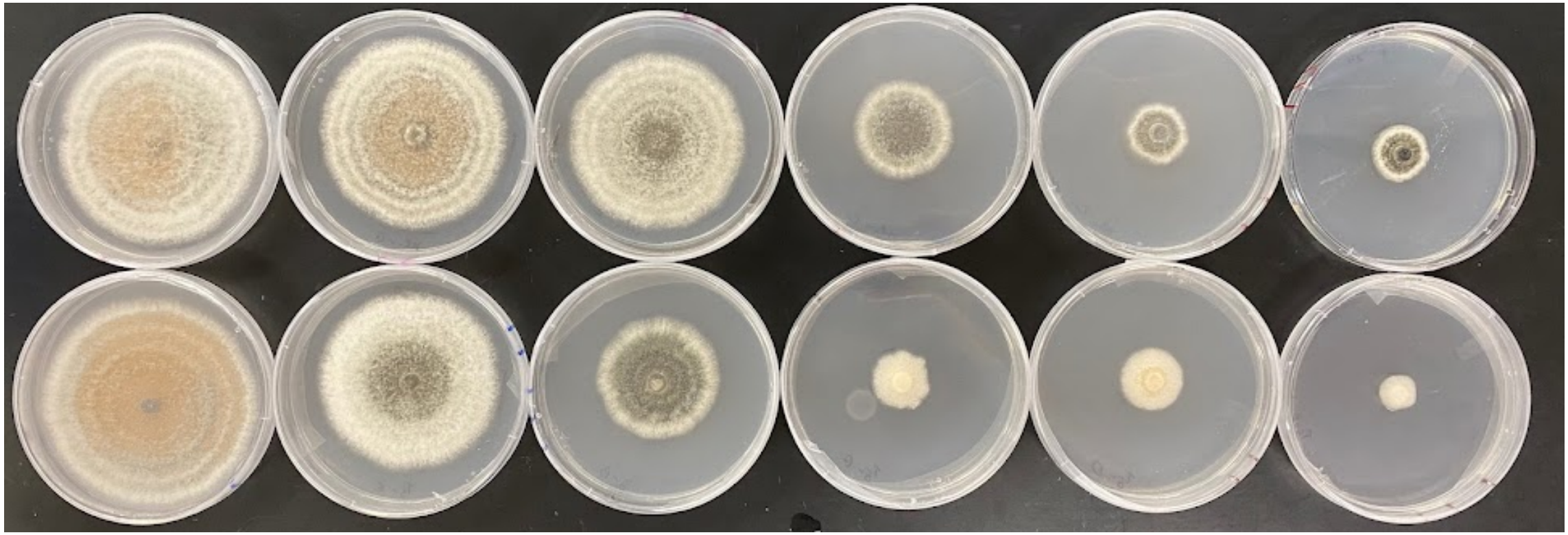
External and internal symptoms of **stem blight**

Thyme & Oregano oils inhibit growth of Anthracnose isolates

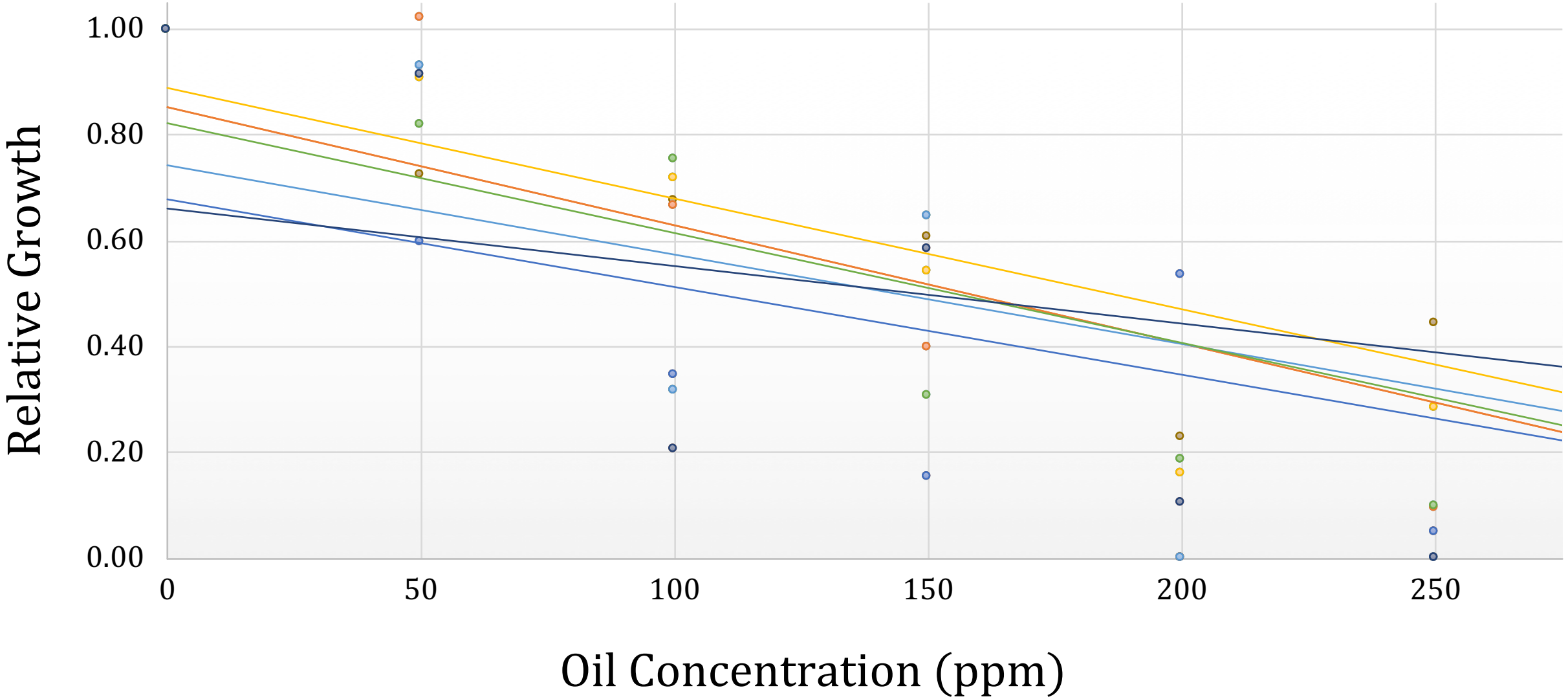
0 50 100 150 200 250 ppm

Thyme oil

Oregano oil



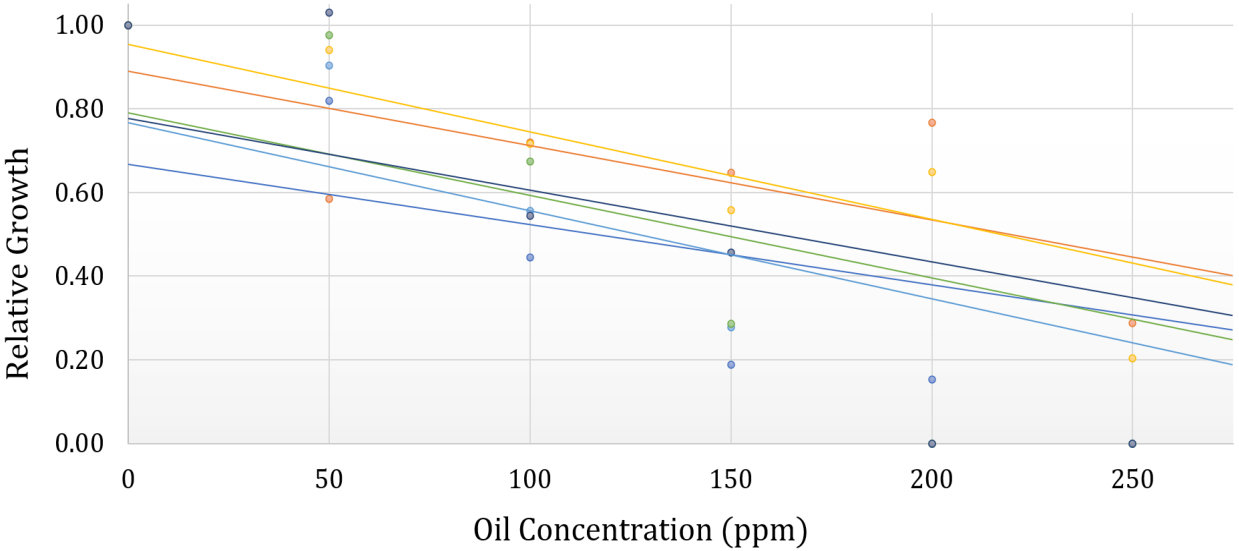
Thyme Oil - Anthracnose isolates



- FL1 - FL2 - FL3 - GA1 - GA2 - GA3

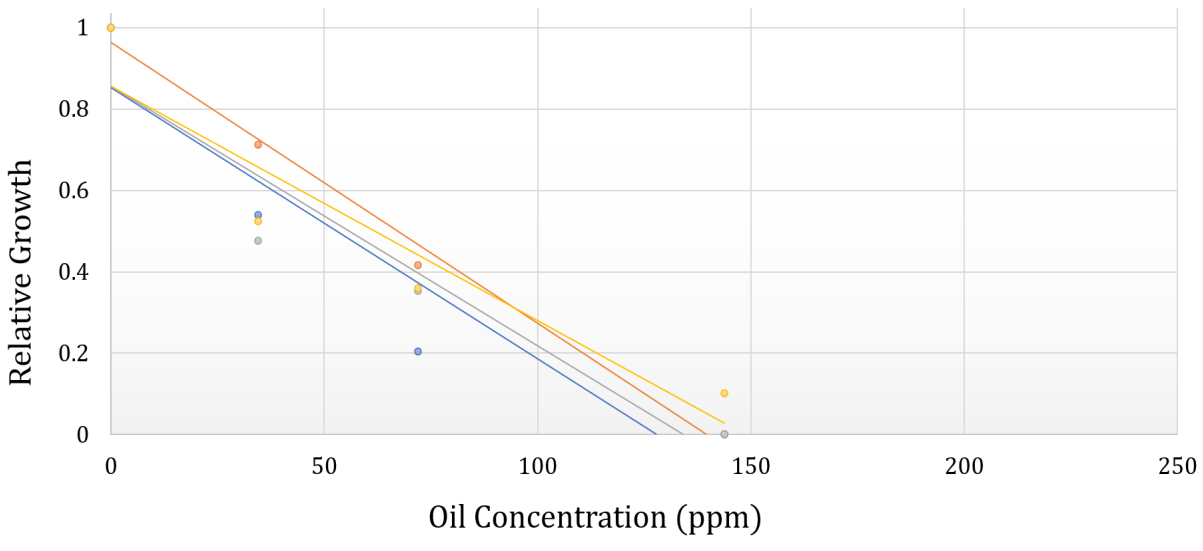
Anthracnose isolates

Oregano Oil



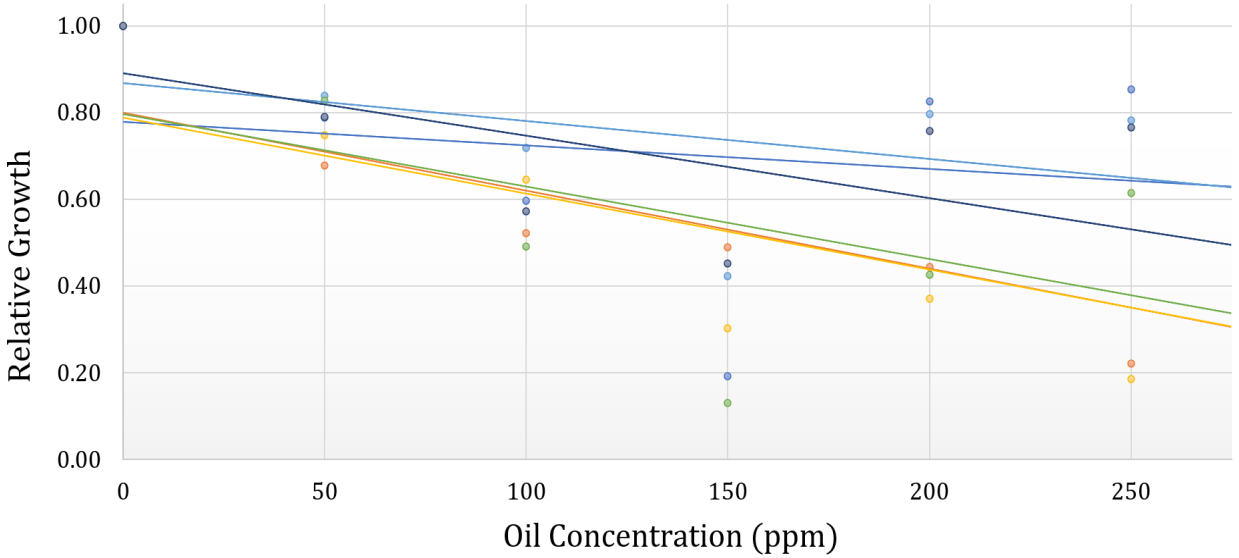
- FL1 - FL2 - FL3 - GA1 - GA2 - GA3

Thyme Guard



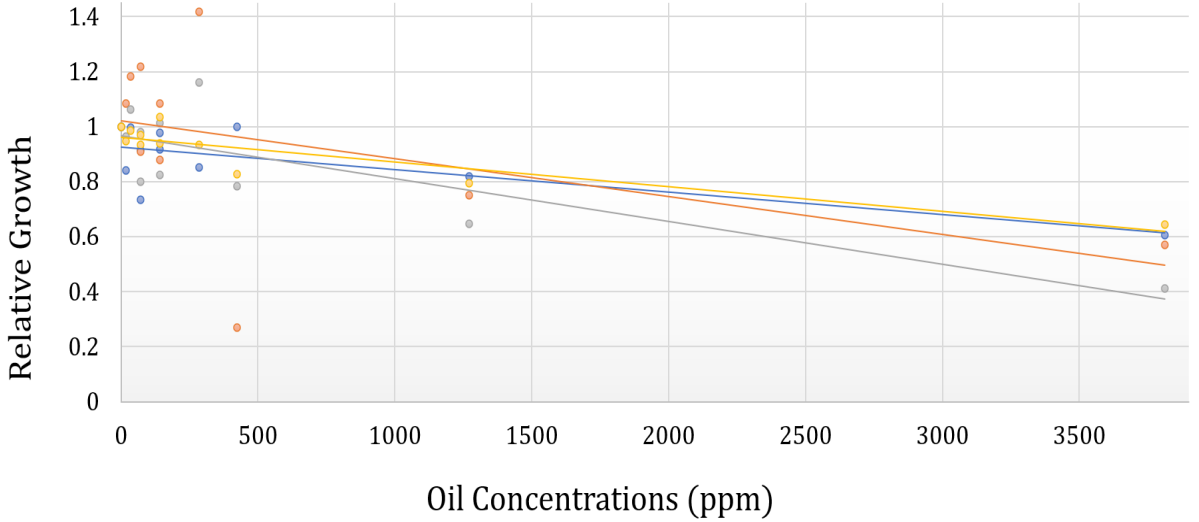
- FL1 - GA1 - GA2 - GA3

Savory Oil



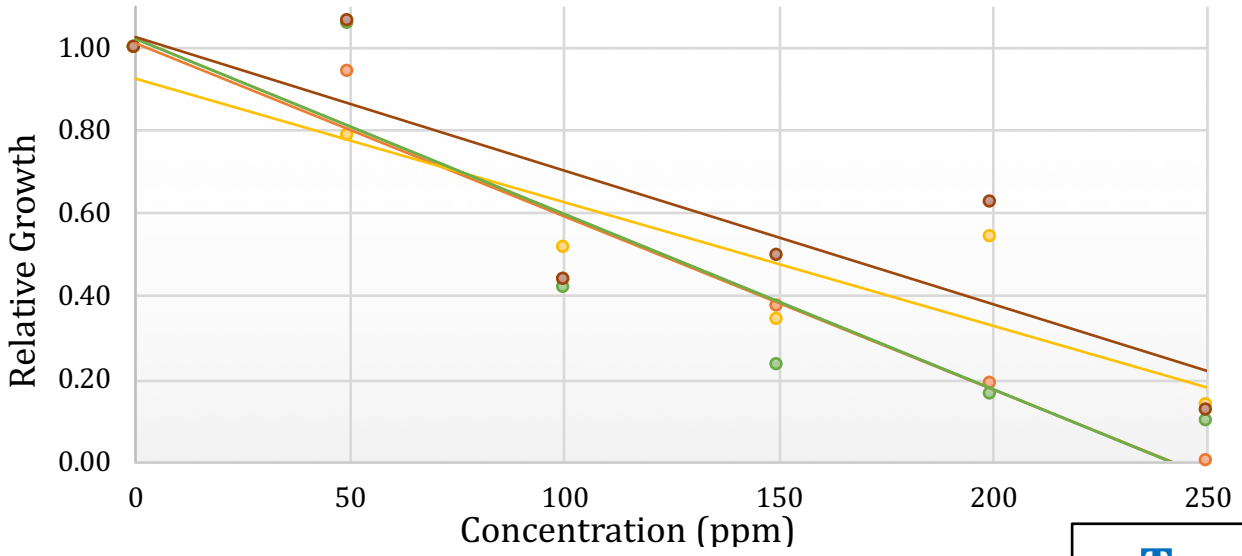
- FL1 - FL2 - FL3 - GA1 - GA2 - GA3

Timorex Act



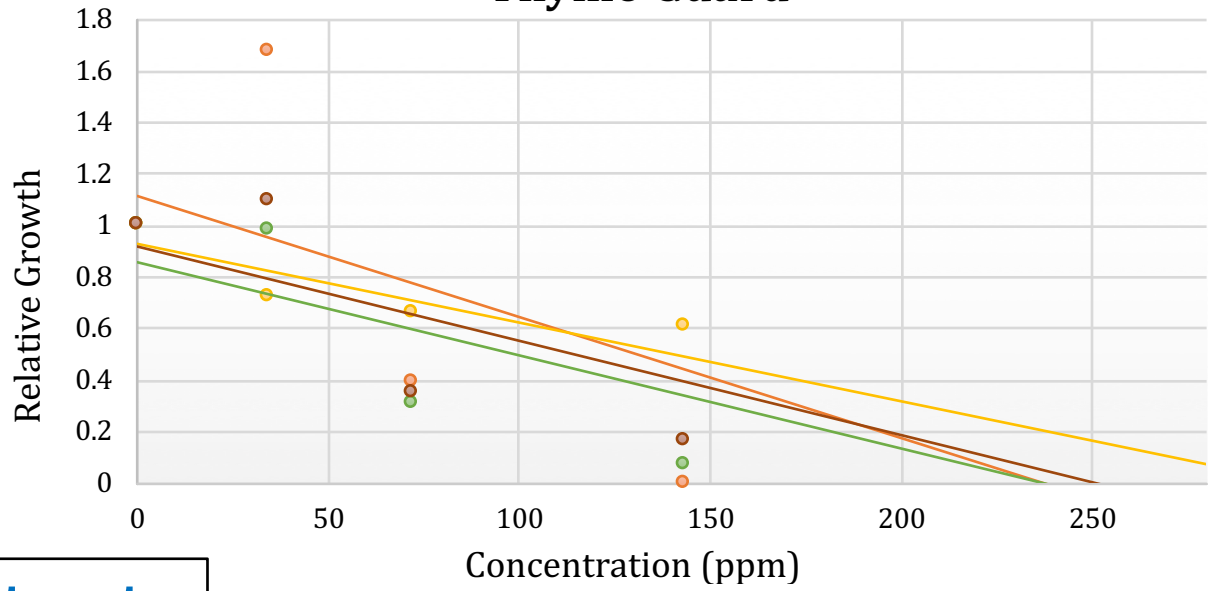
- FL1 - GA1 - GA2 - GA3

Thyme Oil



- CC - NR - LT1 - LT2

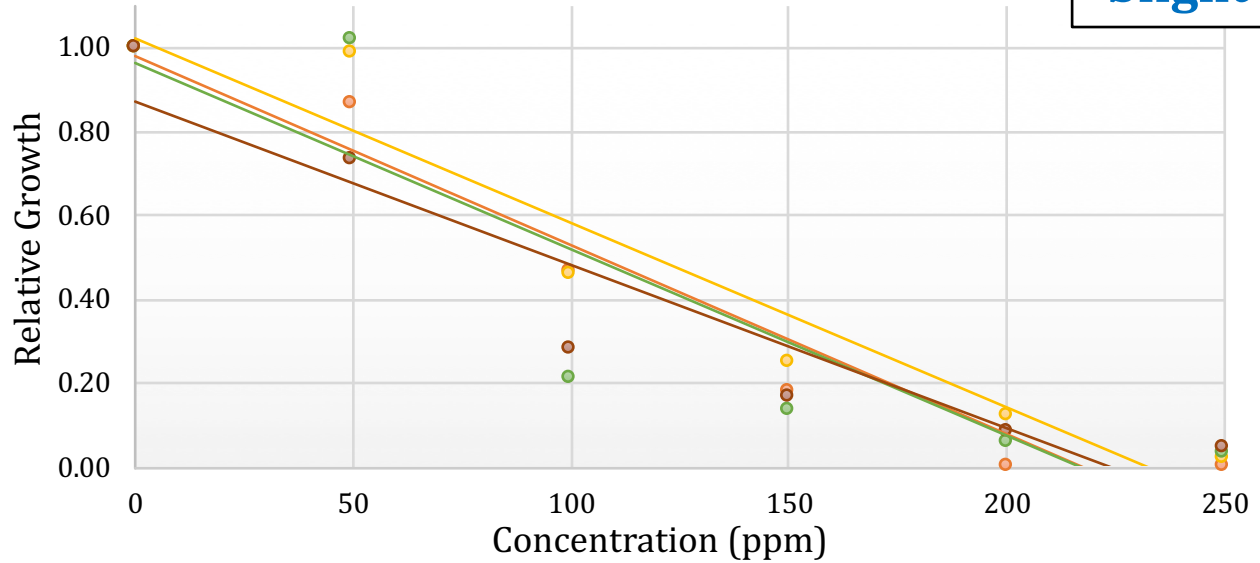
Thyme Guard



- CC - NR - LT1 - LT2

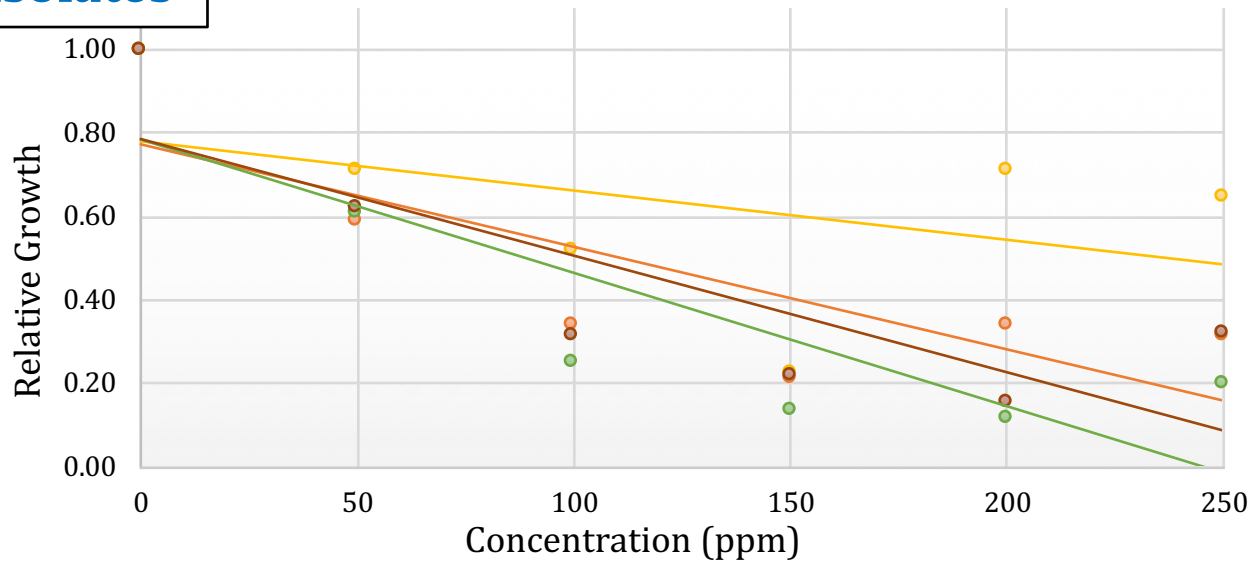
Target spot and stem blight isolates

Oregano Oil



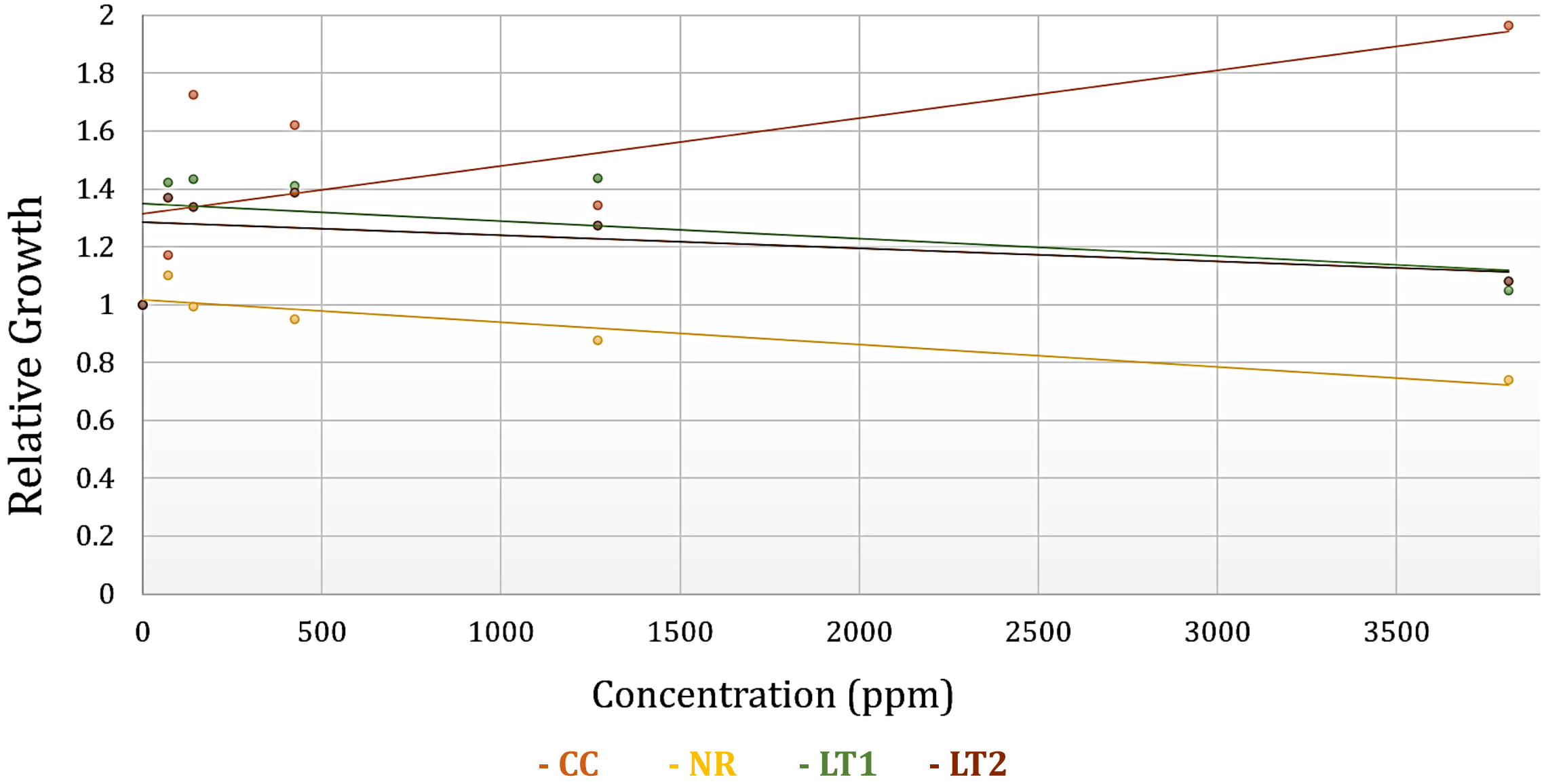
- CC - NR - LT1 - LT2

Savory Oil



- CC - NR - LT1 - LT2

TIMOREX trend lines for target spot and stem blight isolates



Research Question

What is the efficacy of EOs to control fungal diseases of blueberry?

1 – In vitro assays

- Thyme, oregano and savory oils shows varying efficacy against all tested isolates
  - Thyme oil (Thyme Guard included) being the best, followed by oregano and savory oils.
- TIMOREX did not inhibit isolates growth.

Research Question

What is the efficacy of EOs to control fungal diseases of blueberry?

EO-based biopesticides:

- Thyme oil (Thyme Guard®)
- Tea tree oil (TIMOREX ACT®)
- Cinnamon oil (Cinnerate ®)

Compare to:

- Control (non-treated)
- Fungicide (e.g., grower standard or OSO)

Phases

→ 2 – Crop safety evaluation (Phytotoxicity trials)

→ 3 – On-farm trials/Field assessment (Commercial + natural inoculum)

Crop Safety Trials (2021/2023)

- 3 rates of TG & TA were applied to blueberry plants once.
- CIN was applied to peach plants once.
- Untreated plants were used as control.
- Leaves, flowers and fruits were evaluated at day 3, 7, 14 and weekly thereafter until harvest.

			Tested product rates		
Product	**[Conc]**		**Low rate**	**High rate**	**5x High rate**
Cinnerate	60%	oil	600 µl.L^{-1}	1500 µl.L^{-1}	7500 µl.L^{-1}
Thyme Guard	23%	oil	287.5 µl.L^{-1}	1150 µl.L^{-1}	5750 µl.L^{-1}
TIMOREX	23.8%	oil	130.2 µl.L^{-1}	3812 µl.L^{-1}	19060 µl.L^{-1}

TIMOREX
(Tea tree oil)

Thyme Guard
(Thyme oil)

Cinnerate
(Cinnamon oil)

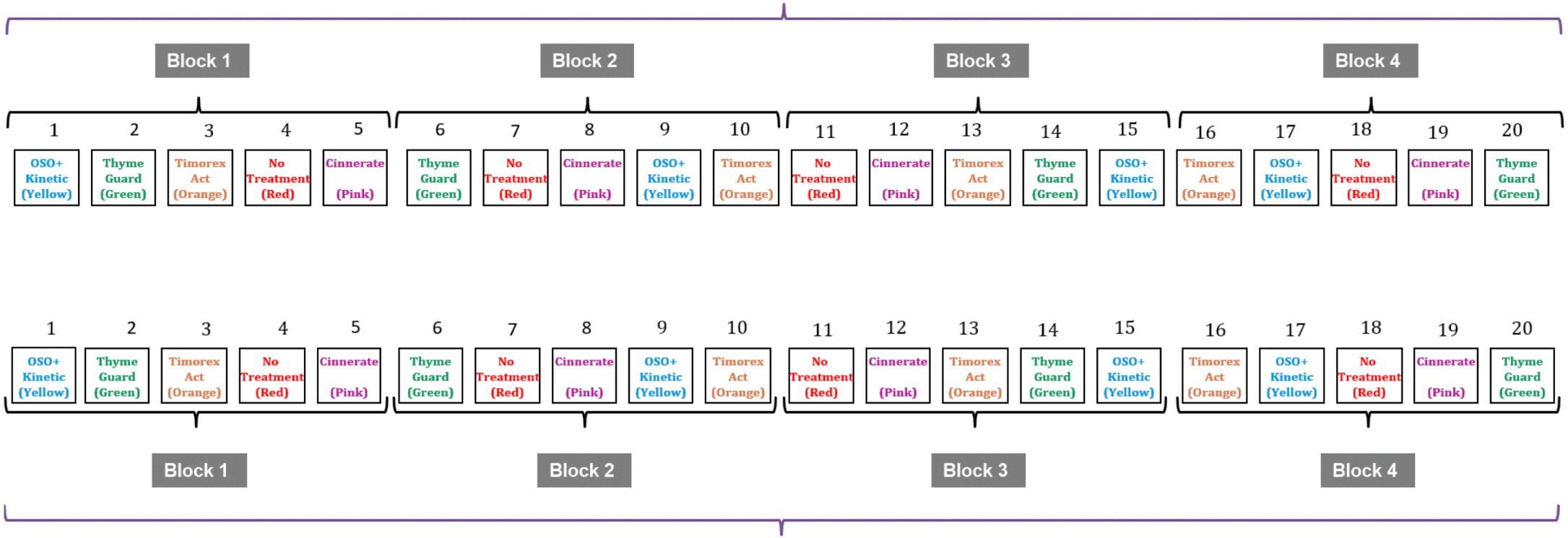
Crop Safety Results (2021/2023)

- No phytotoxicity at recommended rates.
- No phytotoxicity at 5x Cinnerate rate.
- Burn-like symptoms observed on fruits from plants treated with 5x rates of both TIMOREX and Thyme Guard.
  - Less harvestable fruits = Lower yield

Thyme Guard (5x)

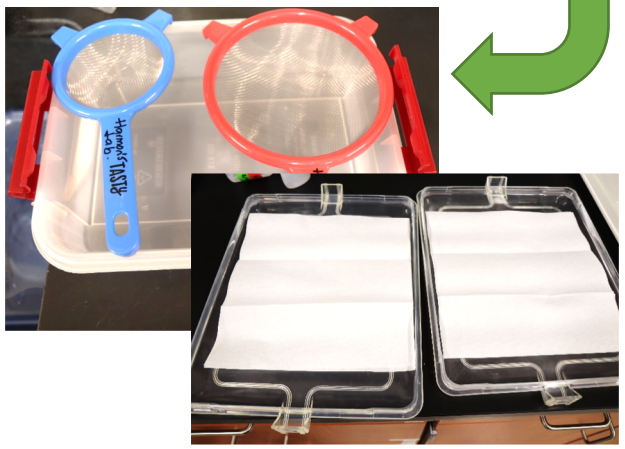
TIMOREX (5x)

Field Trial Set Up

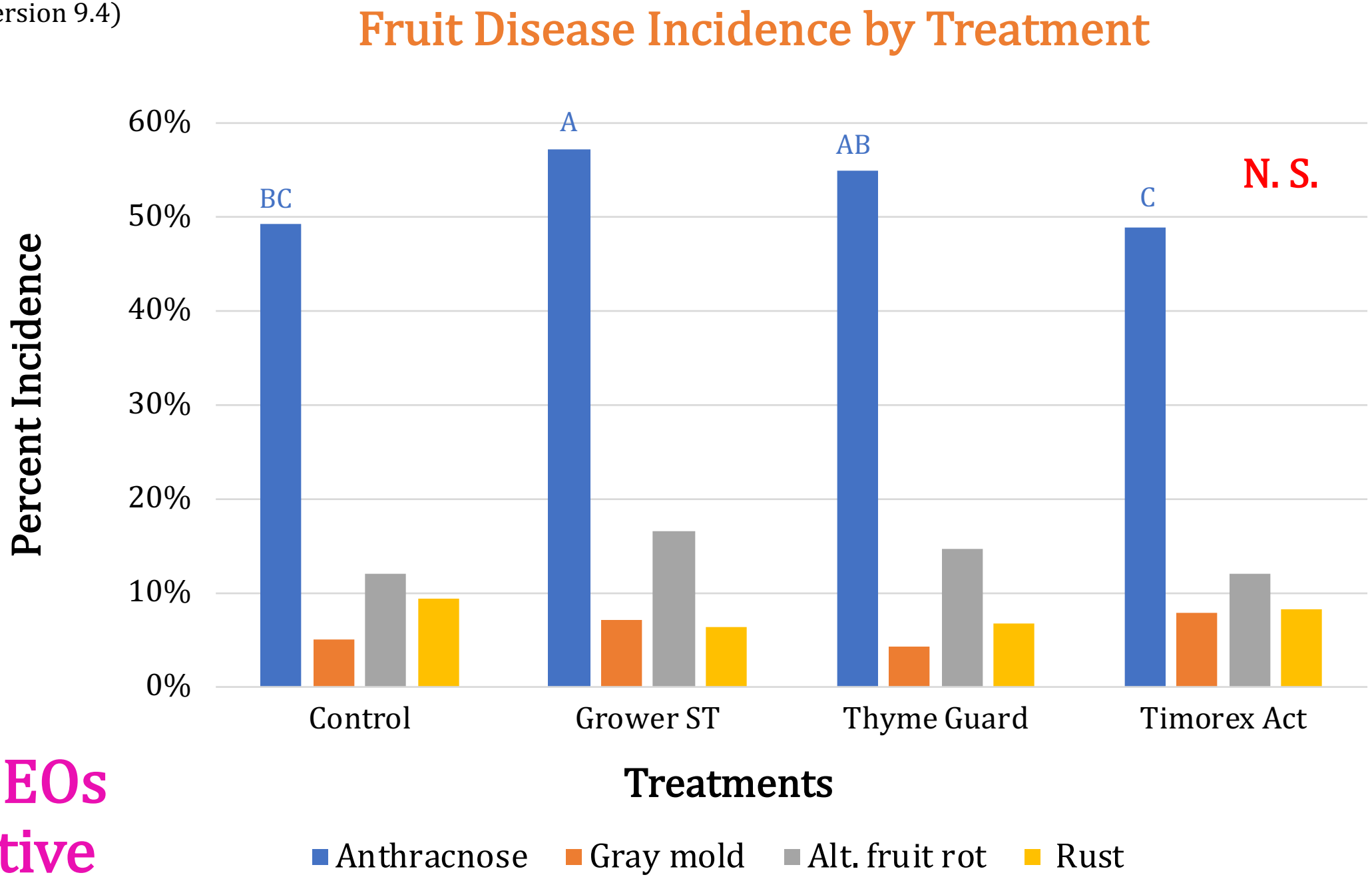


- ❑Four cultivars:
  - ❑Meadowlark
  - ❑Farthing
  - ❑Arcadia
  - ❑Avanti
- ❑4 or 5 Treatments:
  - ❑Non-treated Control
  - ❑Fungicide
  - ❑Thyme Guard at 0.5% (high rate) → $50/A
  - ❑TIMOREX at 1.60% (high rate)
  - ❑Cinnerate at 0.25% (high rate) – 2nd year → $48/A

Fruit Disease Evaluation



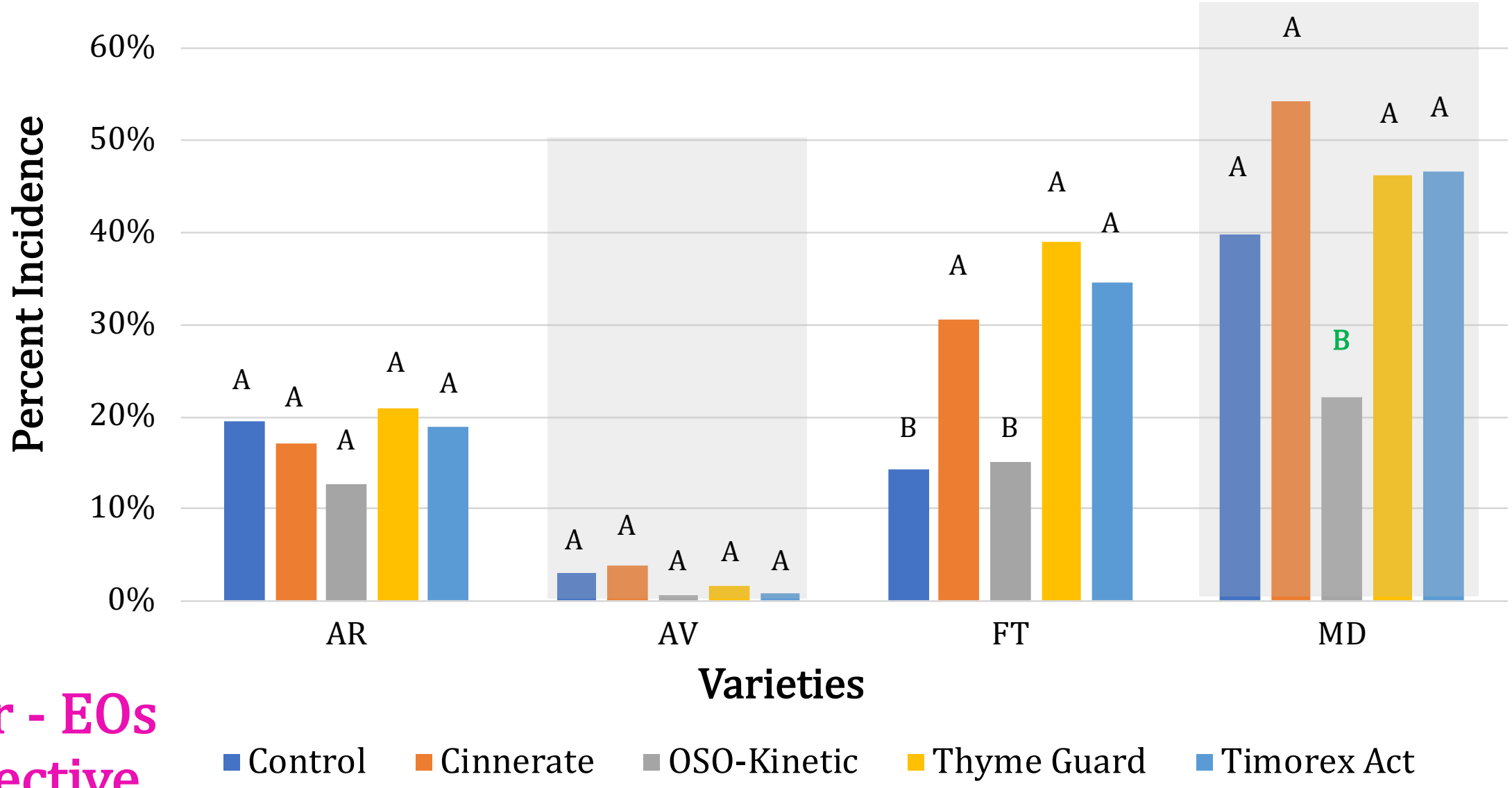
proc mixed and lsmean analyses performed in SAS (version 9.4)



1st year - EOs not effective

proc GLM and Fisher's LSD performed in SAS (version 9.4)

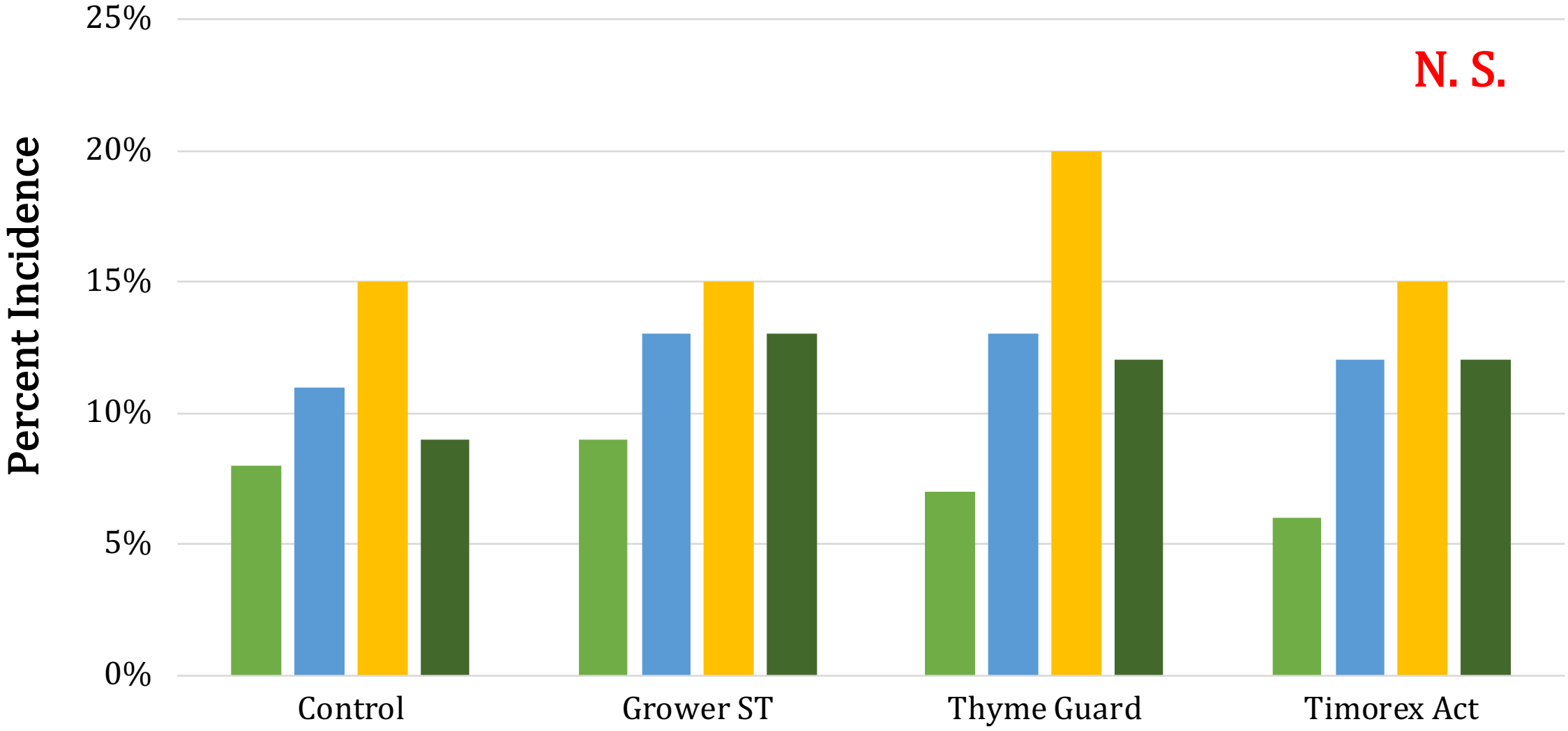
Anthracnose Disease Incidence by Variety



2nd year - EOs not effective

proc mixed and lsmean analyses performed in SAS (version 9.4)

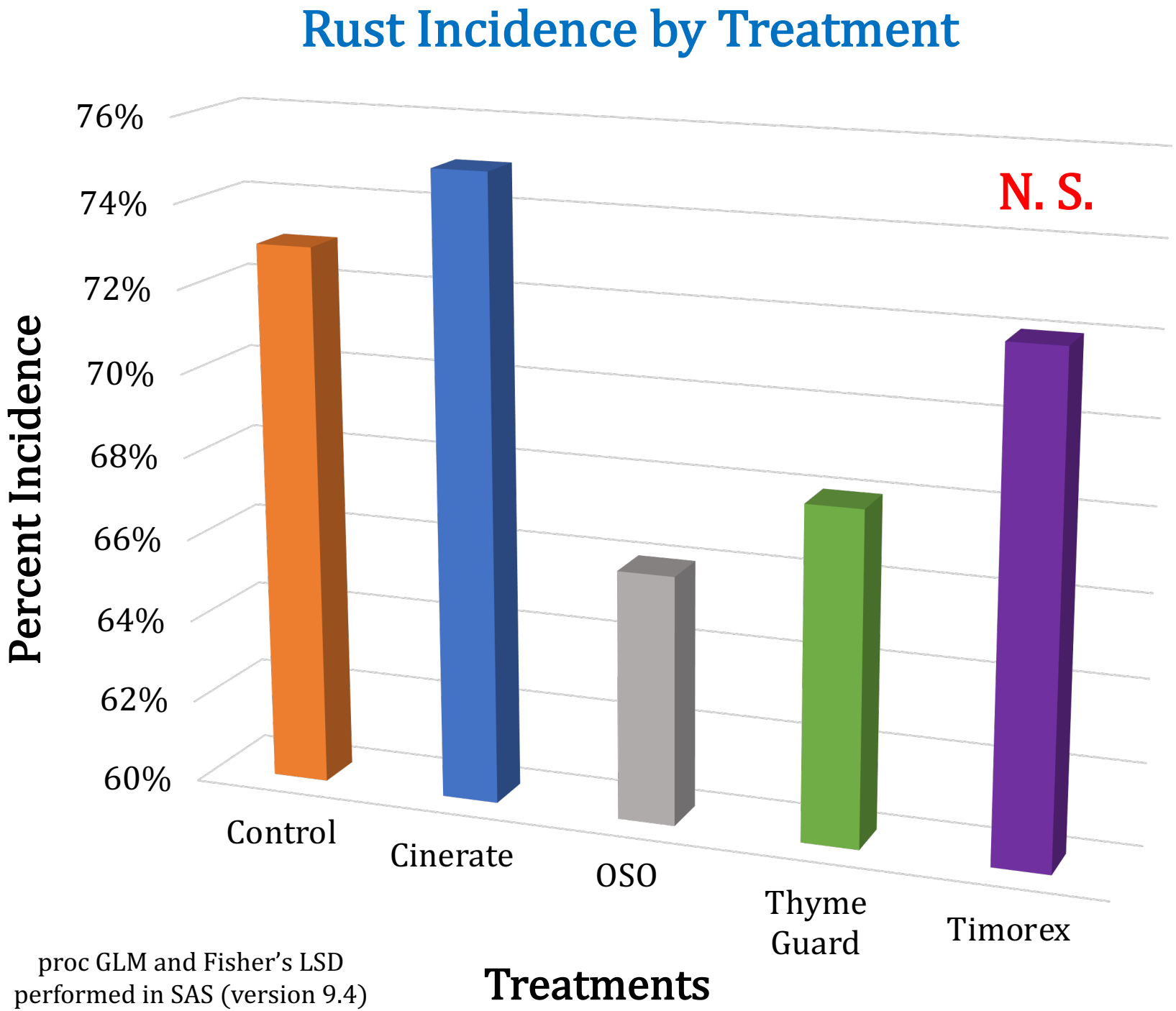
Leaf Disease Incidence by Treatment



1st year - EOs not effective

- No Anthracnose, target spot or Septoria incidence.

- EOs not effective in controlling rust for year 2.



proc GLM and Fisher's LSD performed in SAS (version 9.4)

Take home messages

- Use extreme caution with EO products from bloom to harvest
- Commercial EO products shown to be safe when used according to label instructions for the first year
  - 2nd year: substantial phytotoxicity damages to fruits after multiple applications.

TIMOREX plots sprayed at high recommended rate after 5 applications

Take home messages

- Field evaluations on blueberry failed to demonstrate efficacy under conditions tested.
  - OSO (polyoxin D) shows potential as a possible organic fungicide against Anthracnose on blueberry.

Ongoing Investigations

- Research is continuing in post-harvest disease management:
  - Using these EO and different delivery methods:
    - Vapor (pure oils)
    - Dipping (pure oils and formulated EO products)
    - Edible coating: brushing vs. spraying

Future Investigations

- Volatilization important to EOs antimicrobial efficacy, so work still needs to be done on biopesticide formulation.
  - Reduce EO volatilization:
    - Slow or timed release/Product delivery
    - Application timing, etc.

Thank you for your time and attention!

Questions?

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