TIMOREX ACT® a new OMRI listed bio-fungicide that controls fungal and bacterial plant pathogens

2023 Industry Technology Session (IR-4 meeting July 20)

Eric Tedford, Summit Agro

What is Tea Tree Oil ?

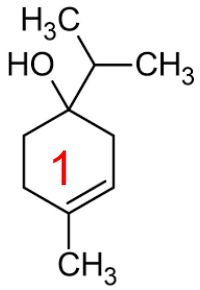
- Derived from the leaves of the tea tree, *Melaleuca alternifolia*
- **Tea tree oil is an essential oil used originally in alternative medicine.**
- **Not an oil in the classic sense – not phytotoxic, can be used with adjuvants**

***Extract* Composition of *Melaleuca alternifolia* (Tea Tree Oil)**

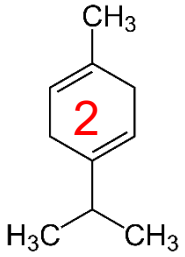
Component	%
Terpinen-4-ol	40.1
Ɣ-Terpinene	23.0
α-Terpinene	10.4
1,8-Cineole	5.1
Terpinolene	3.1
P-Cymene	2.9
α-Pinene	2.6
α-Terpineol	2.4

Bringing 8 players to the game increases the chances of winning

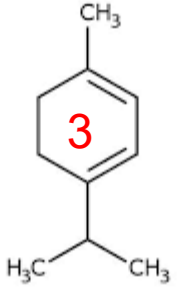
Terpinen-4-ol



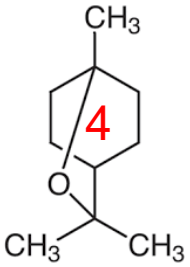
Y-Terpinene



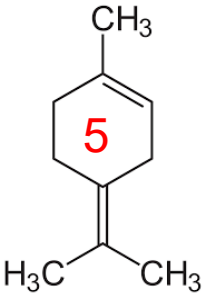
α - *Terpenene*



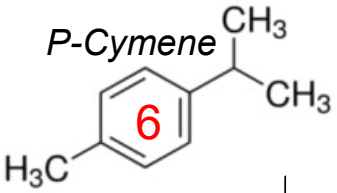
1,8 - Cineole



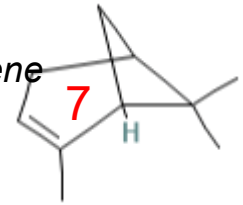
Terpinolene



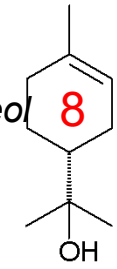
P-Cymene



α - *Pinene*

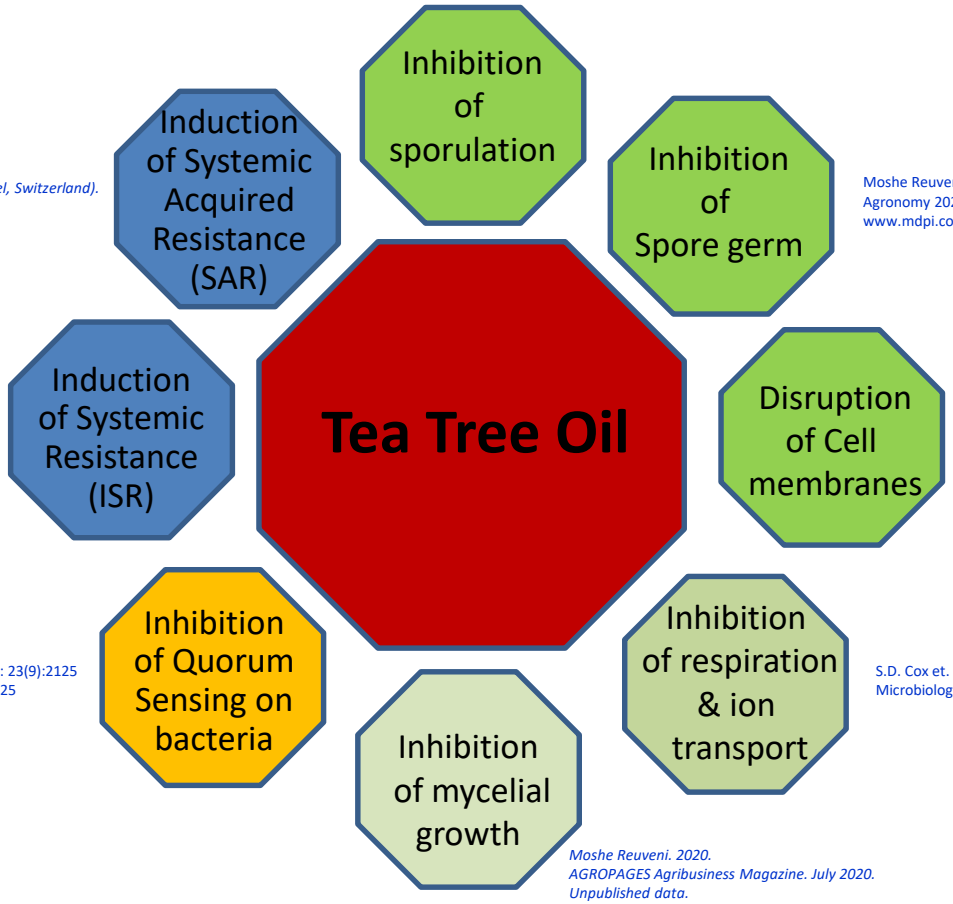


α - *Terpineol*



TTO Multiple Mechanisms Activity

Moshe Reuveni and Yigal Cohen.
Agronomy 2020, 10, 838; doi:10.3390/agronomy 10060836
www.mdpi.com/journal/agonomy



R.J.D. Dalio et. al. Plants (Basel, Switzerland). 9. 10.3390/plants9091137.

Moshe Reuveni and Yigal Cohen.
Agronomy 2020, 10, 838; doi:10.3390/agronomy 10060836
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R.J.D. Dalio et. al. Plants (Basel, Switzerland). 9.10.3390/plants 9091137.

Moshe Reuveni, et. Al. Agronomy. 2020. 10, 609; doi:10.3390/agronomy10040609
www.mdpi.com/journal/agonomy

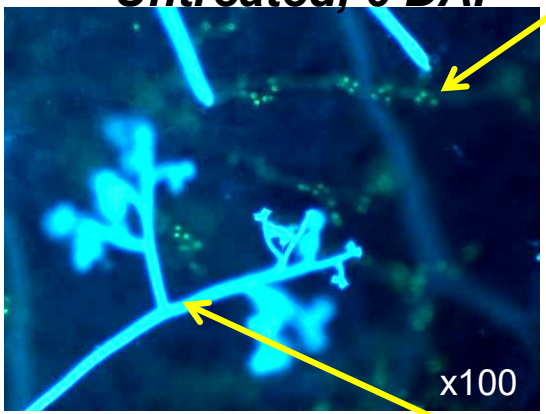
J-P. Poli, et. al. Molecules 2018: 23(9):2125
doi: 10.3390/molecules23092125

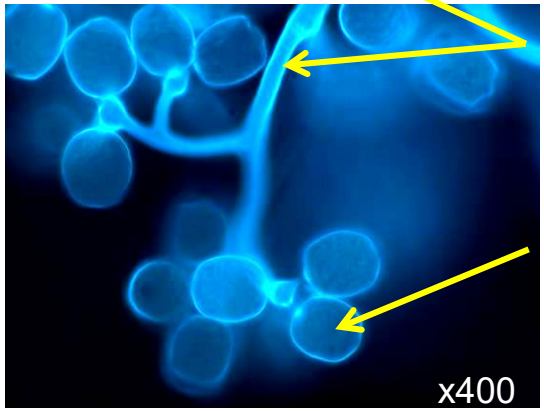
S.D. Cox et. al. 1998. Letters in Applied Microbiology; 26: 355-358.

Moshe Reuveni. 2020.
AGROPAGES Agribusiness Magazine. July 2020.
Unpublished data.

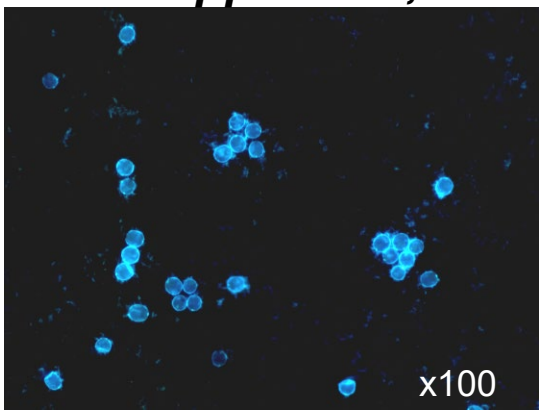
TTO disrupts sporulation

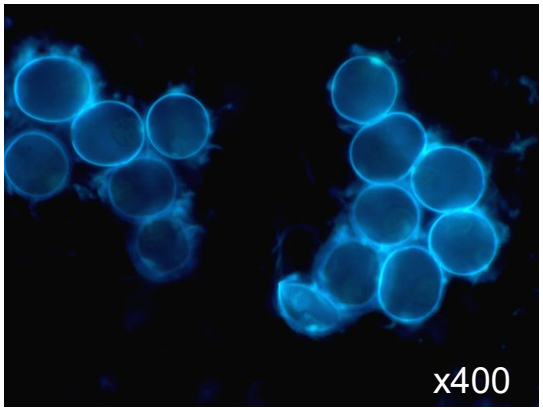
Untreated, 6 DAI





2500 ppm TTO, 6 DAI





No conidia (spore) germination

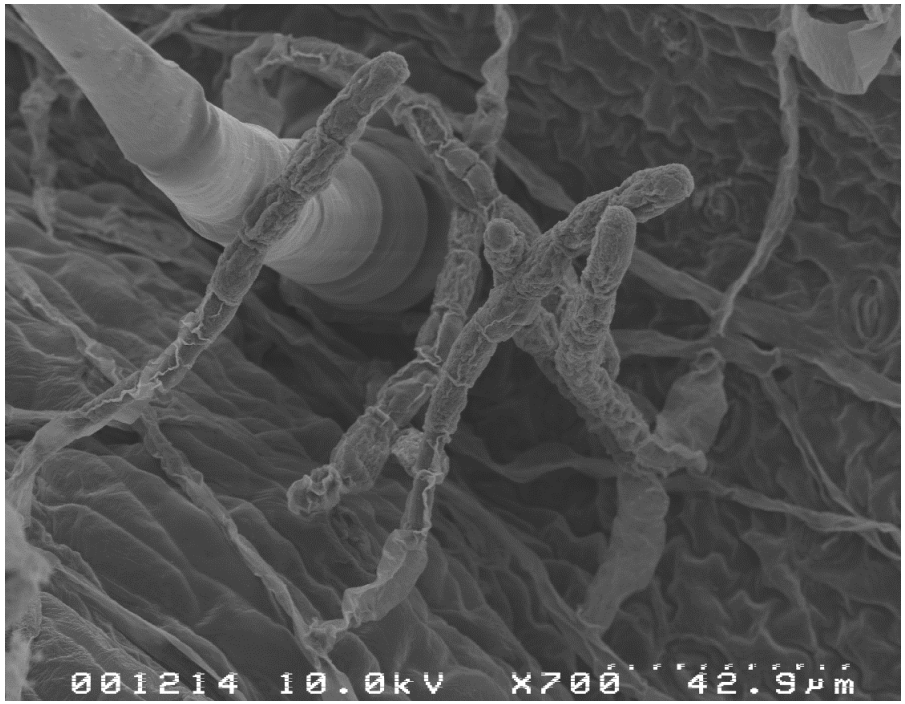
No Infection structure development

No colonization nor sporulation

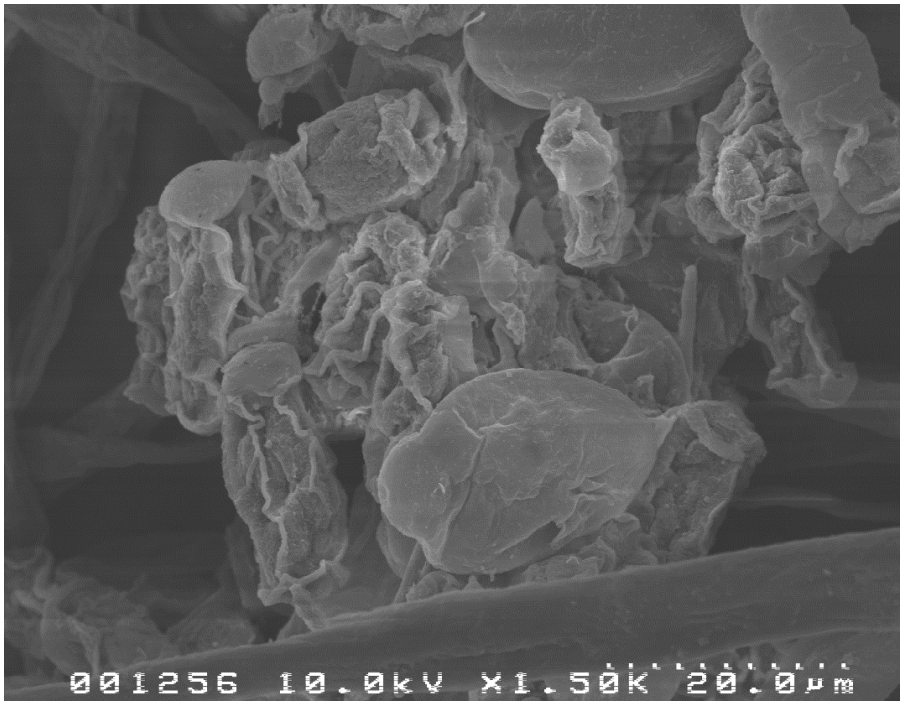
Moshe Reuveni and Yigal Cohen. Agronomy 2020, 10, 838; doi:10.3390/agronomy 10060836 www.mdpi.com/journal/agonomy

TTO disrupts normal sporulation

Untreated



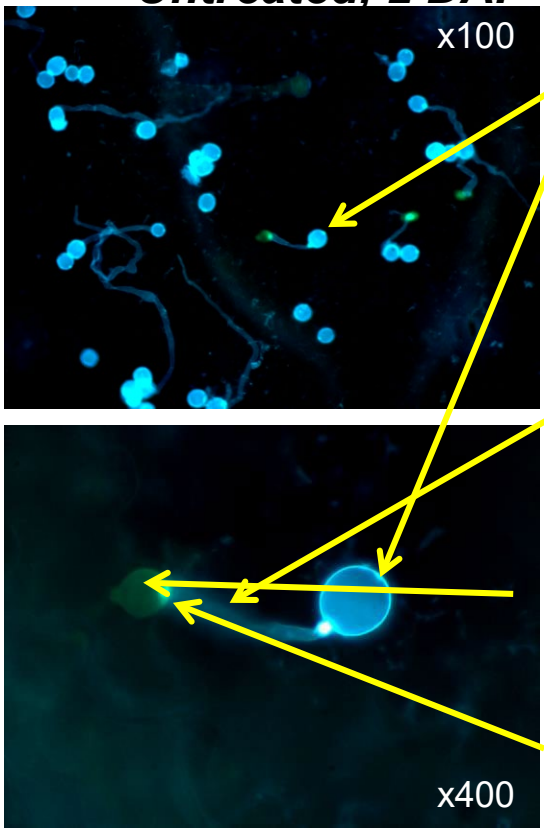
TTO Treated



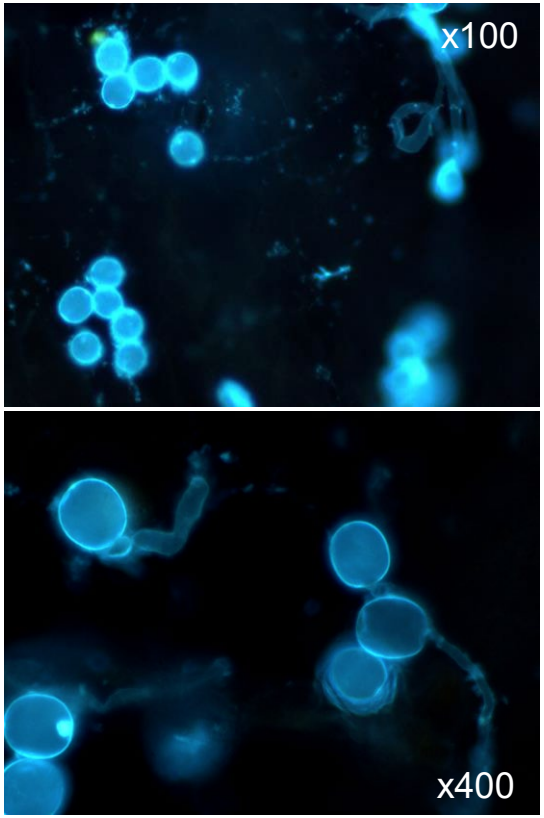
Moshe Reuveni, et. al. Agronomy. 2020.
10, 609; doi:10.3390/agronomy10040609
www.mdpi.com/journal/agonomy

TTO disrupts spore germination & the infection process

Untreated, 2 DAI



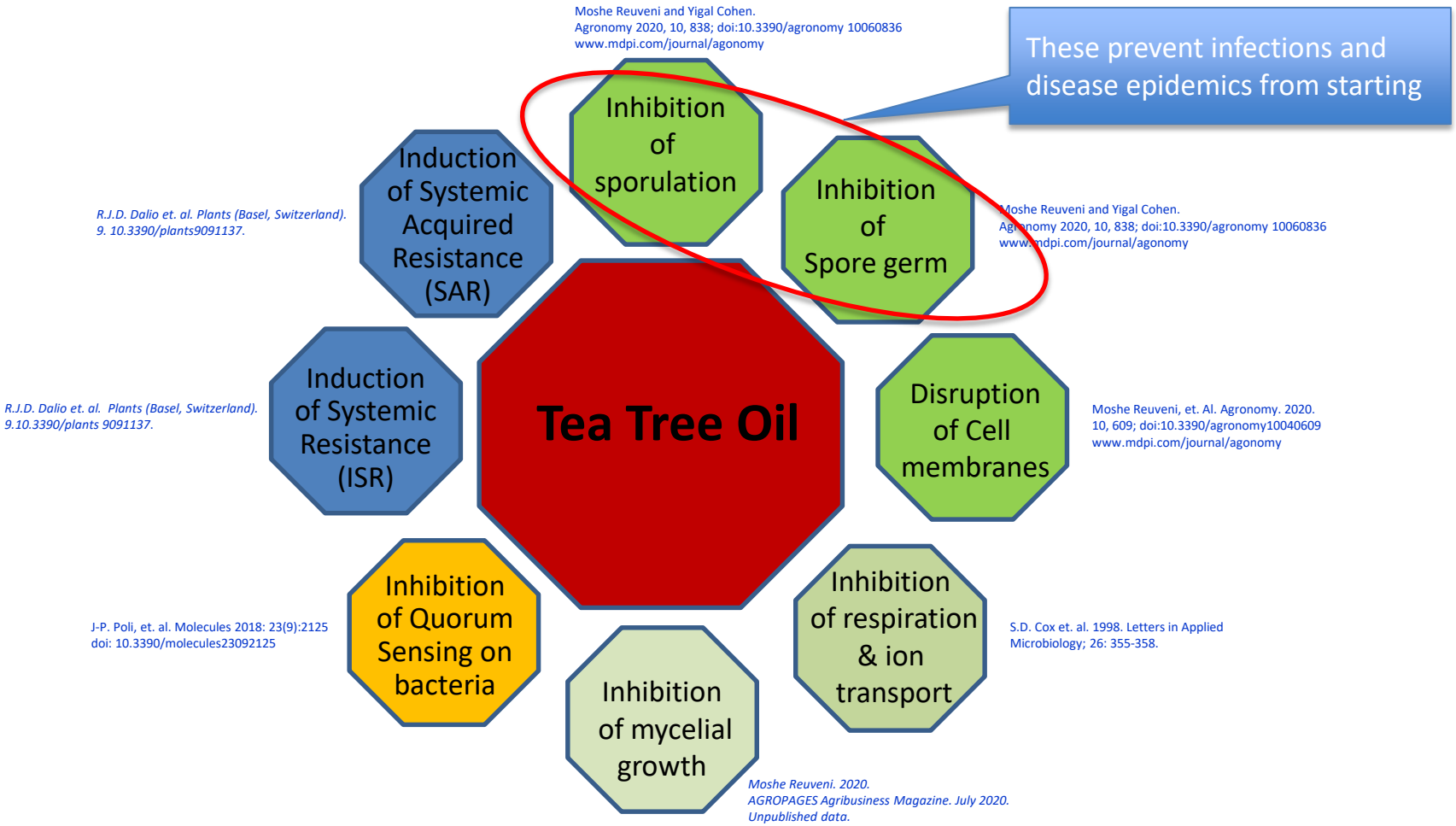
TTO treated, 2 DAI



Conidia with low germination and no infection vesicle formation

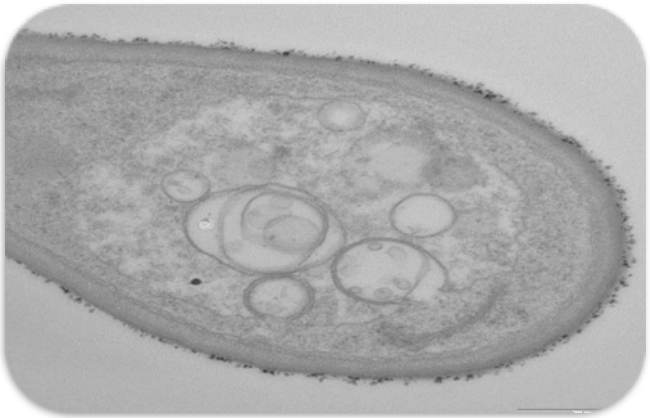
Moshe Reuveni and Yigal Cohen. Agronomy 2020, 10, 838; doi:10.3390/agronomy 10060836 www.mdpi.com/journal/agonomy

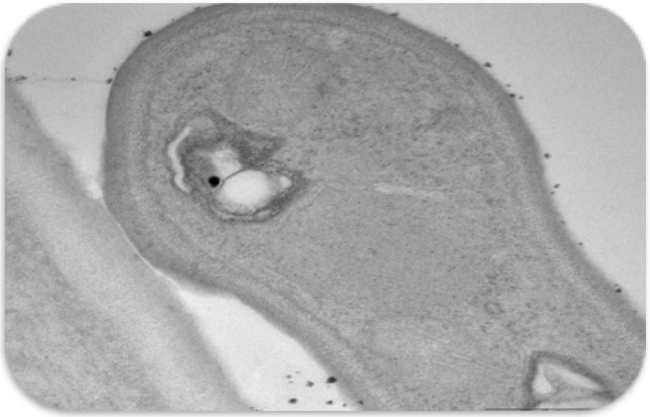
TTO Multiple Mechanisms Activity



Unique Mode of Action of TTO kills both fungi + bacteria

Untreated



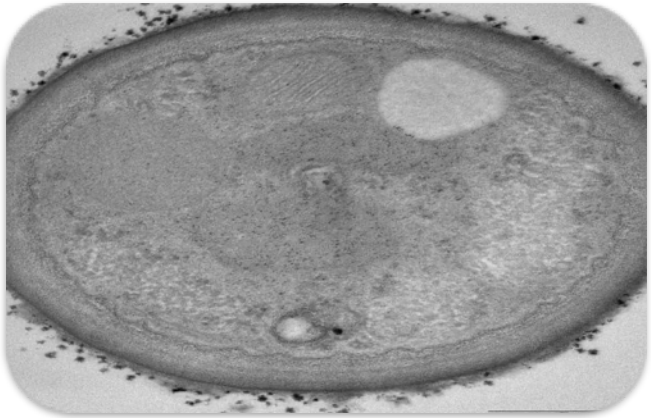


Mineral Oil

TTO breaks the cell wall and cell membrane of the fungus

Magnification x50,000

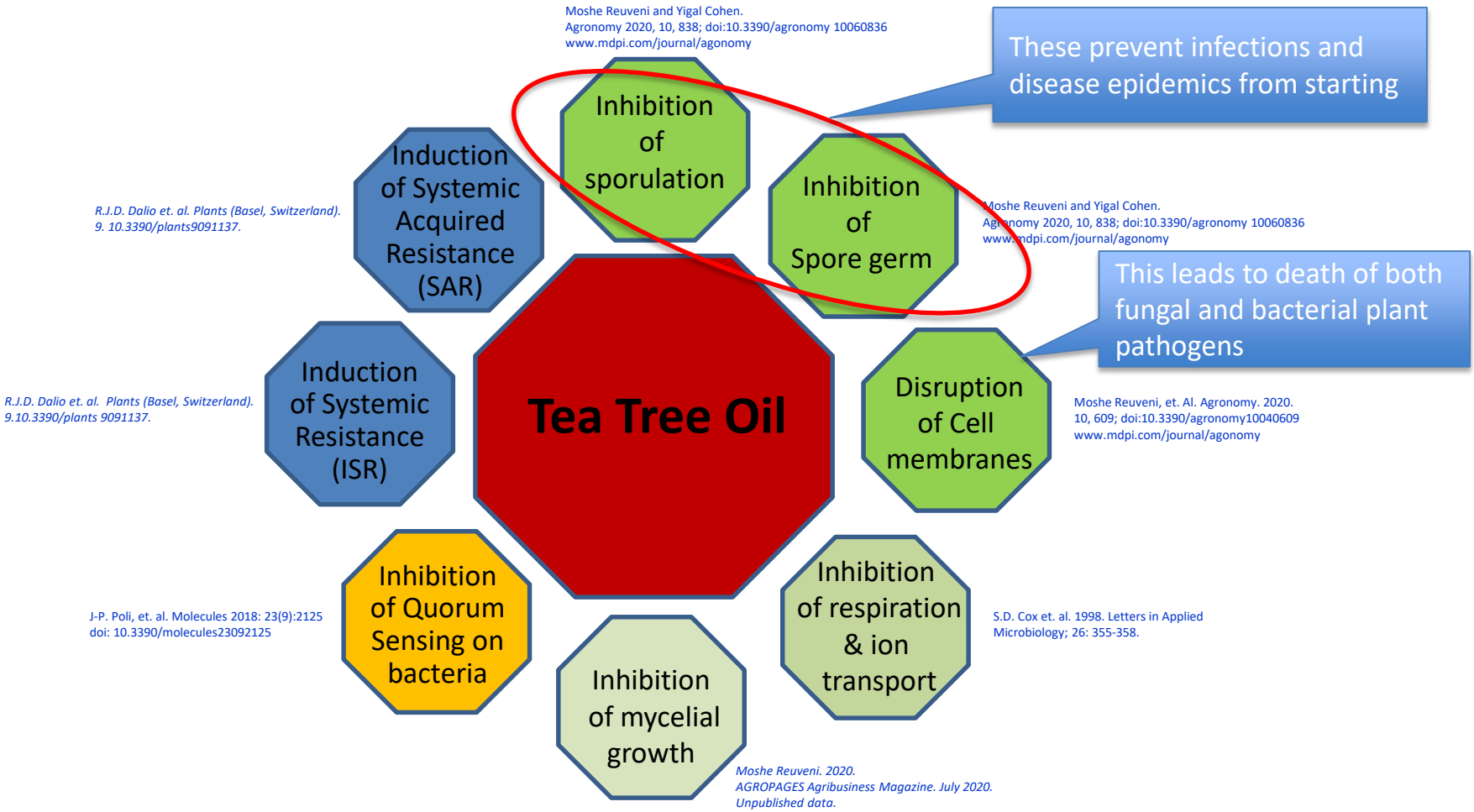
Tea Tree Oil



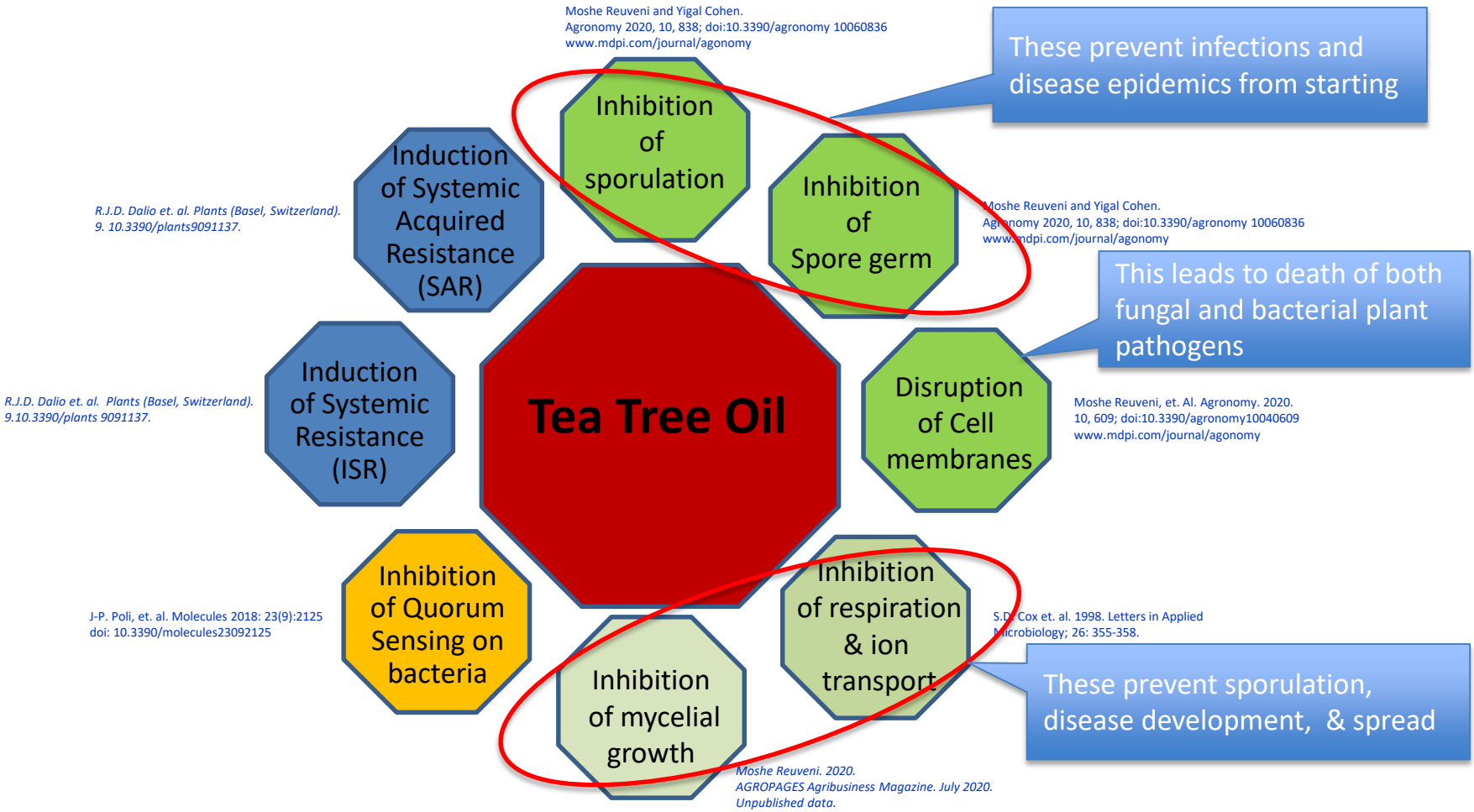
Triazole

Hyphae of Mycosphaerella fijiensis. M. Reuveni, E. Sanches, and M. Barbier.
Curative and Suppressive Activities of Essential Tea Tree Oil against Fungal Plant Pathogens. Agronomy 2020, 10, 609; doi:10.3390/agronomy10040609

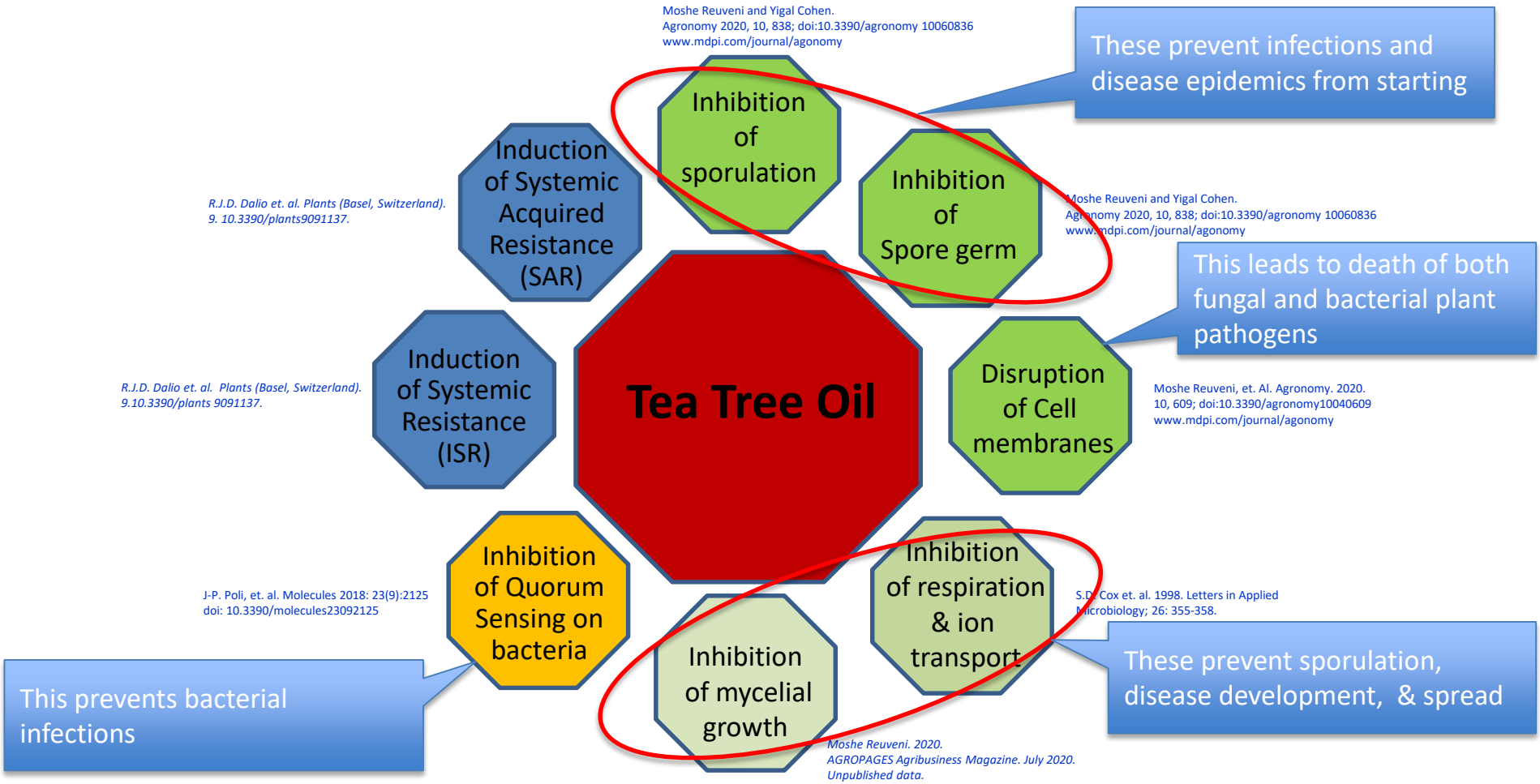
TTO Multiple Mechanisms Activity



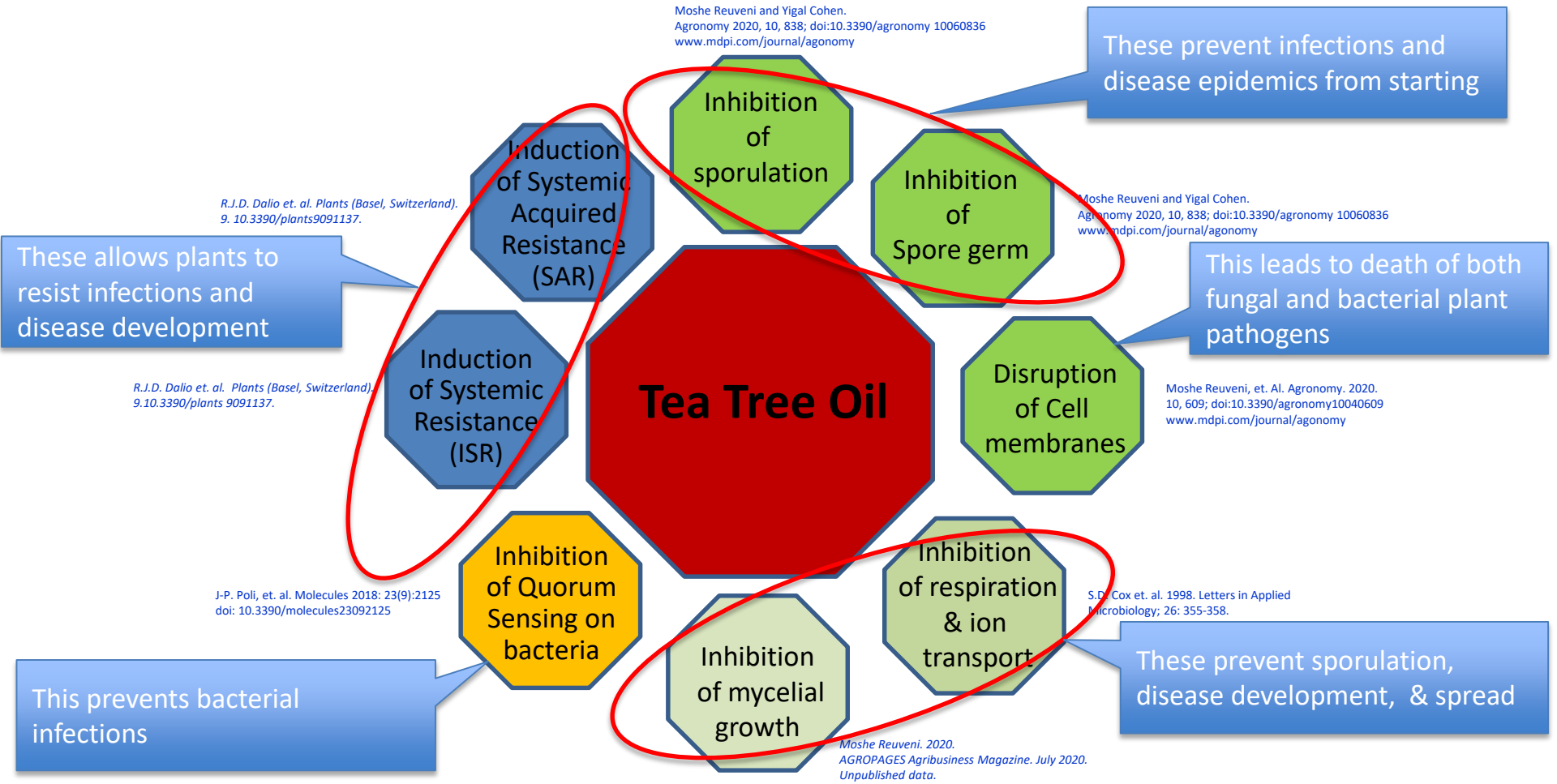
TTO Multiple Mechanisms Activity



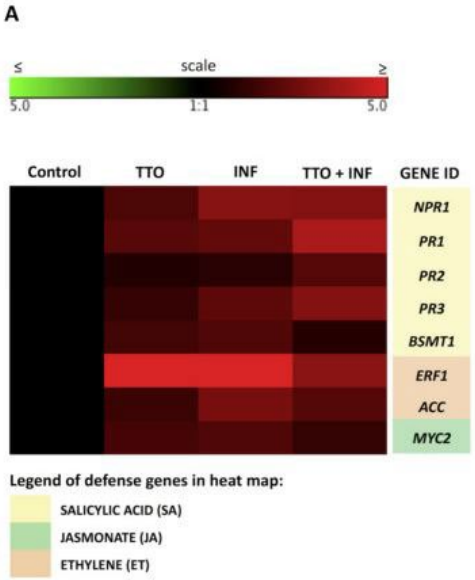
TTO Multiple Mechanisms Activity



TTO Multiple Mechanisms Activity



TTO induces Systemic Resistance in plants



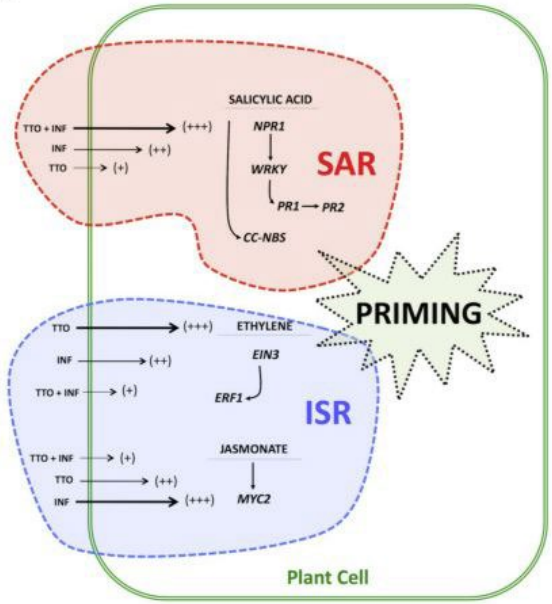
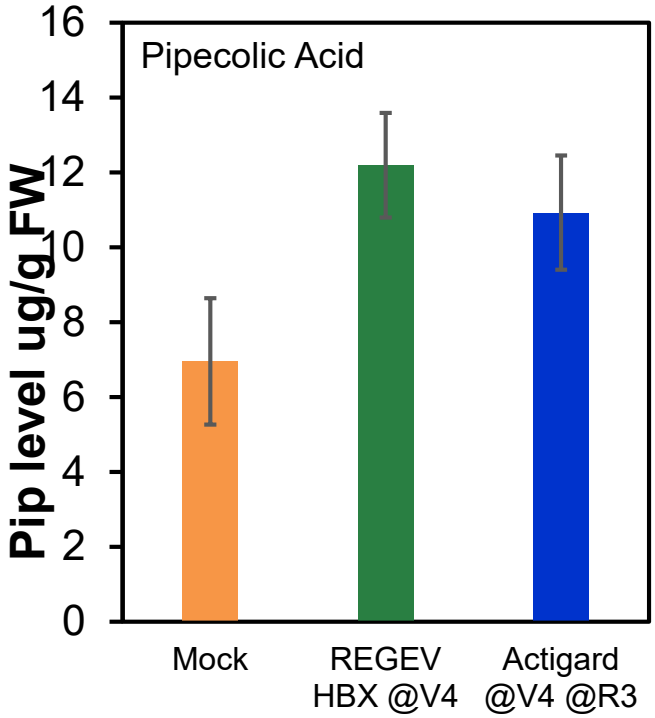
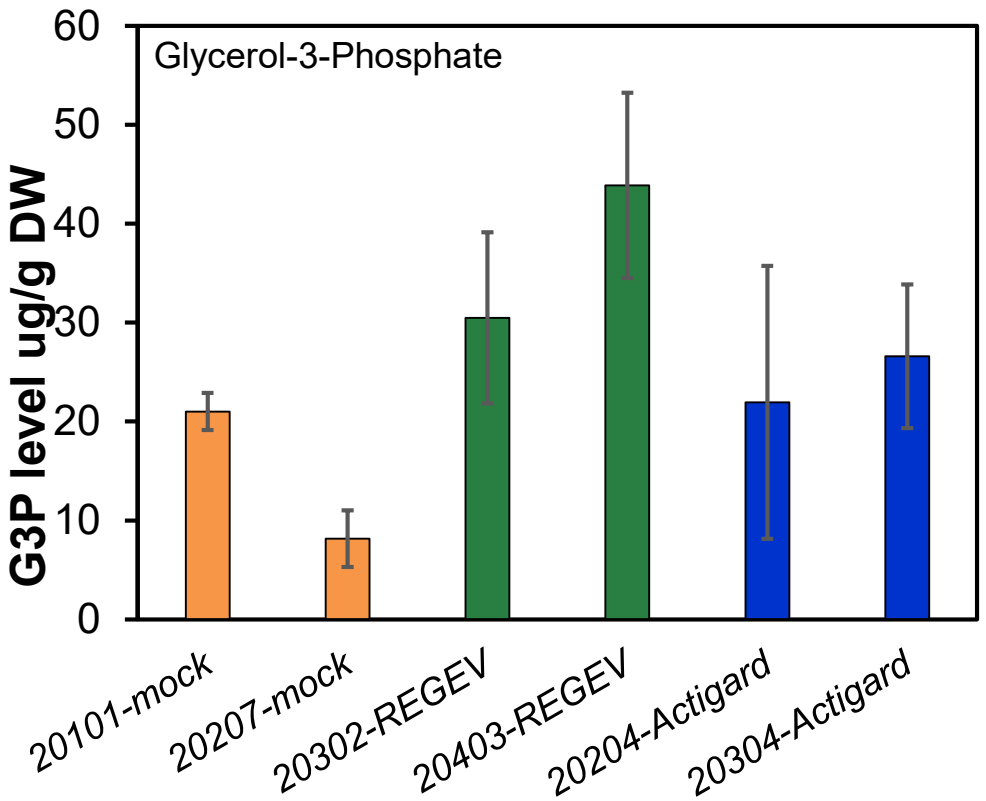


Figure 1. Acquired systemic resistance (SAR) and induced systemic resistance (ISR) via priming is activated by TTO in banana trees infected *Fusarium oxysporum f. sp. cubense* (Foc) race 1. Leaf sprays of TTO on infected mother banana trees induced protection against *Fusarium oxysporum f. sp. cubense* (Foc) race 1 in new plants (daughters) developed.

R.J.D. Dalio et. al. Tea Tree Oil Induces Systemic Resistance against Fusarium wilt in Banana and Xanthomonas infection in Tomato Plants. Plants (Basel) 2020 Sep 2; 9(9):1137.doi: 10.3390/plants9091137.

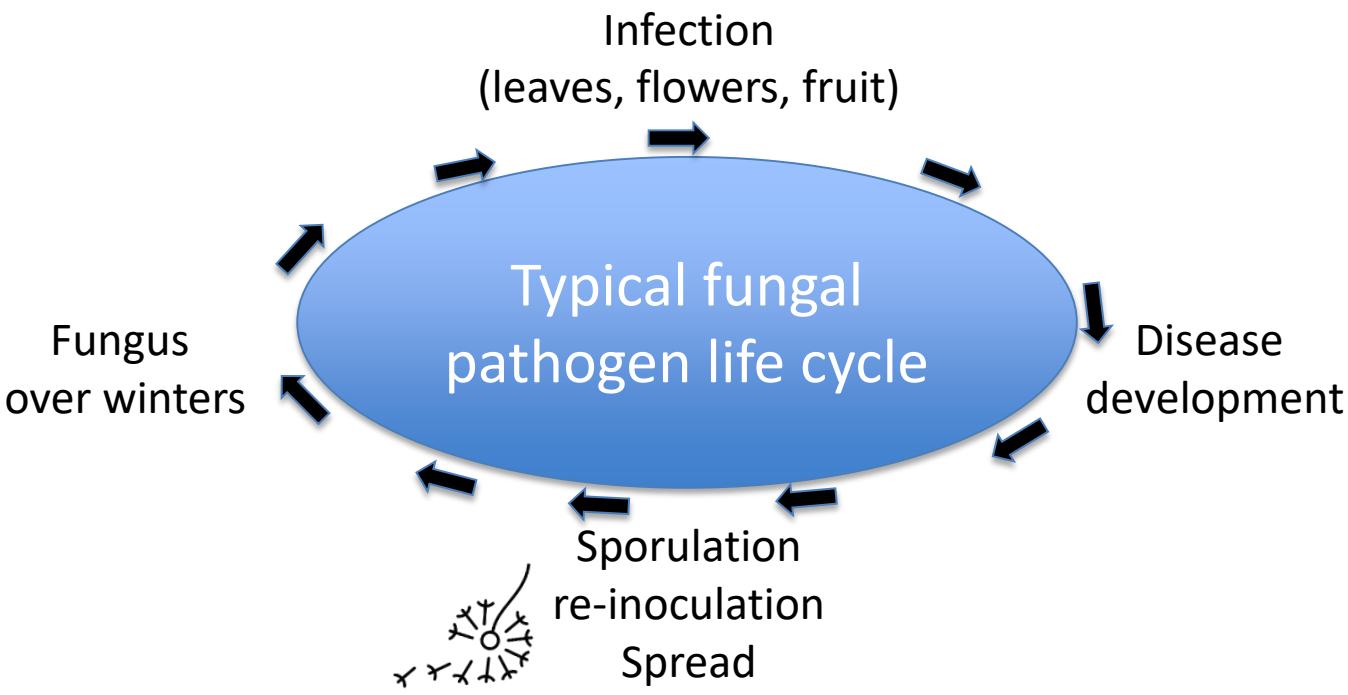
Regev HBX has SAR activity on soybeans



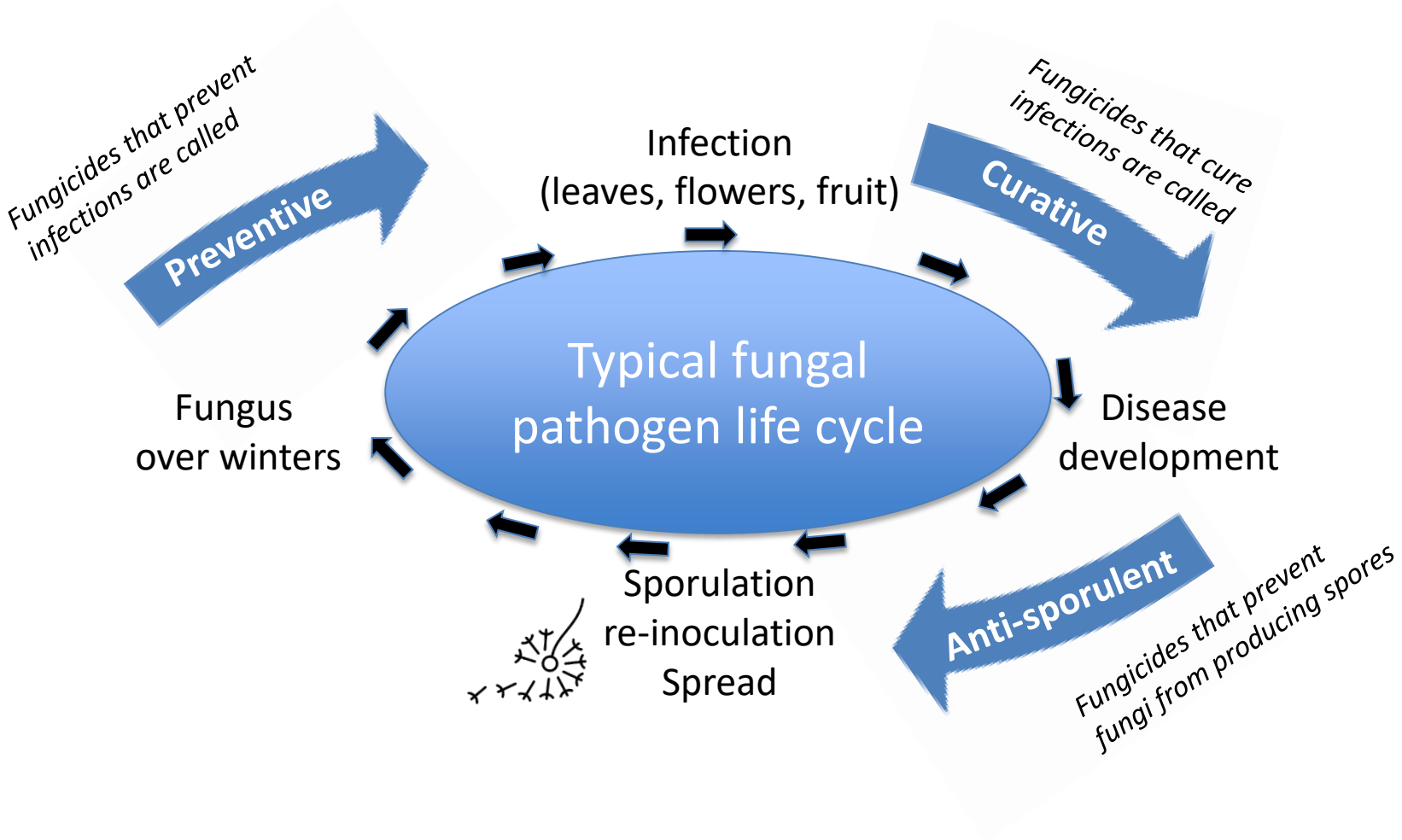


SAUS725 Aardra Kachroo, Lexington, KY. 2022

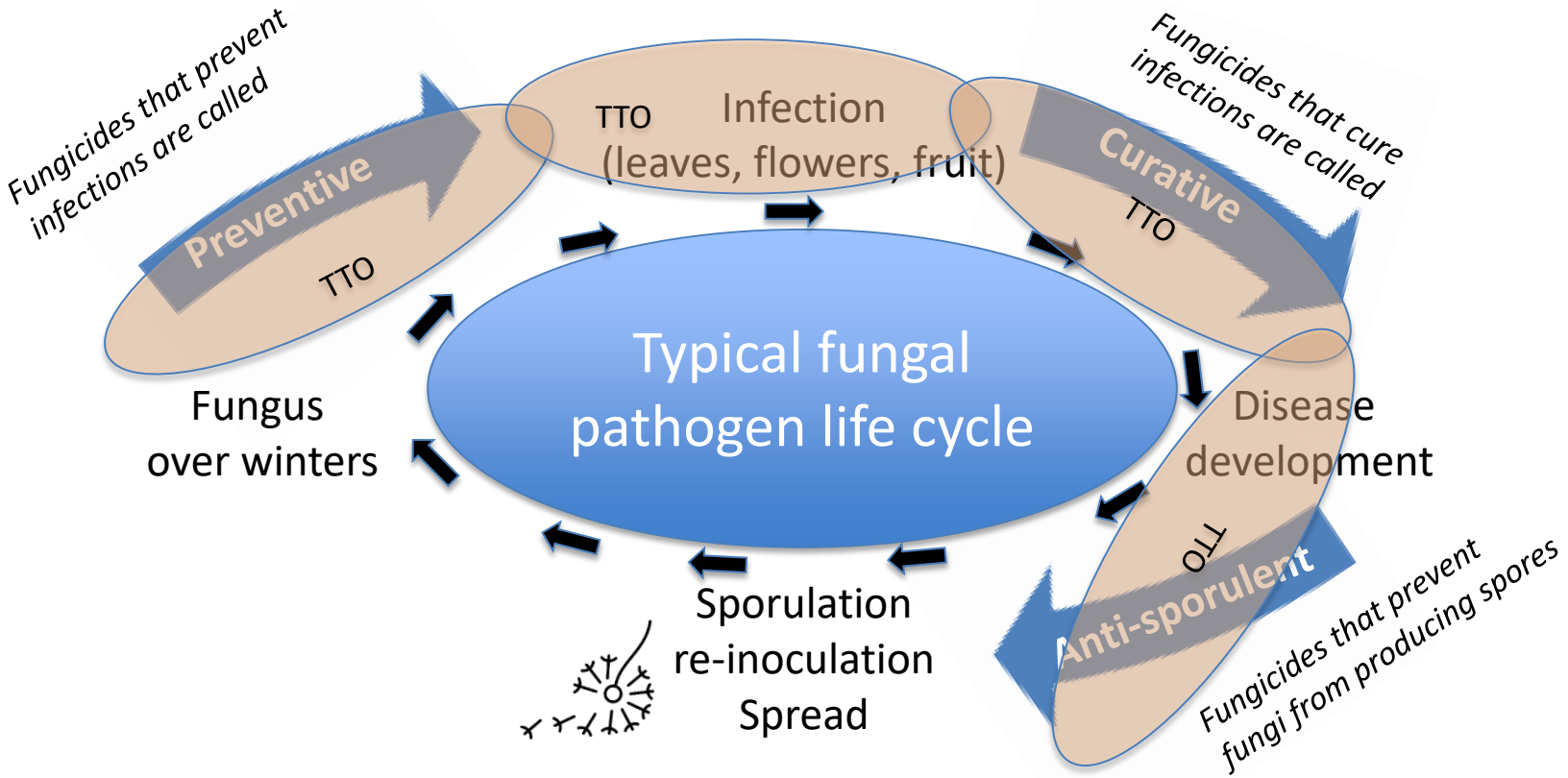
TTO provides preventive, curative, and anti-sporulan activity



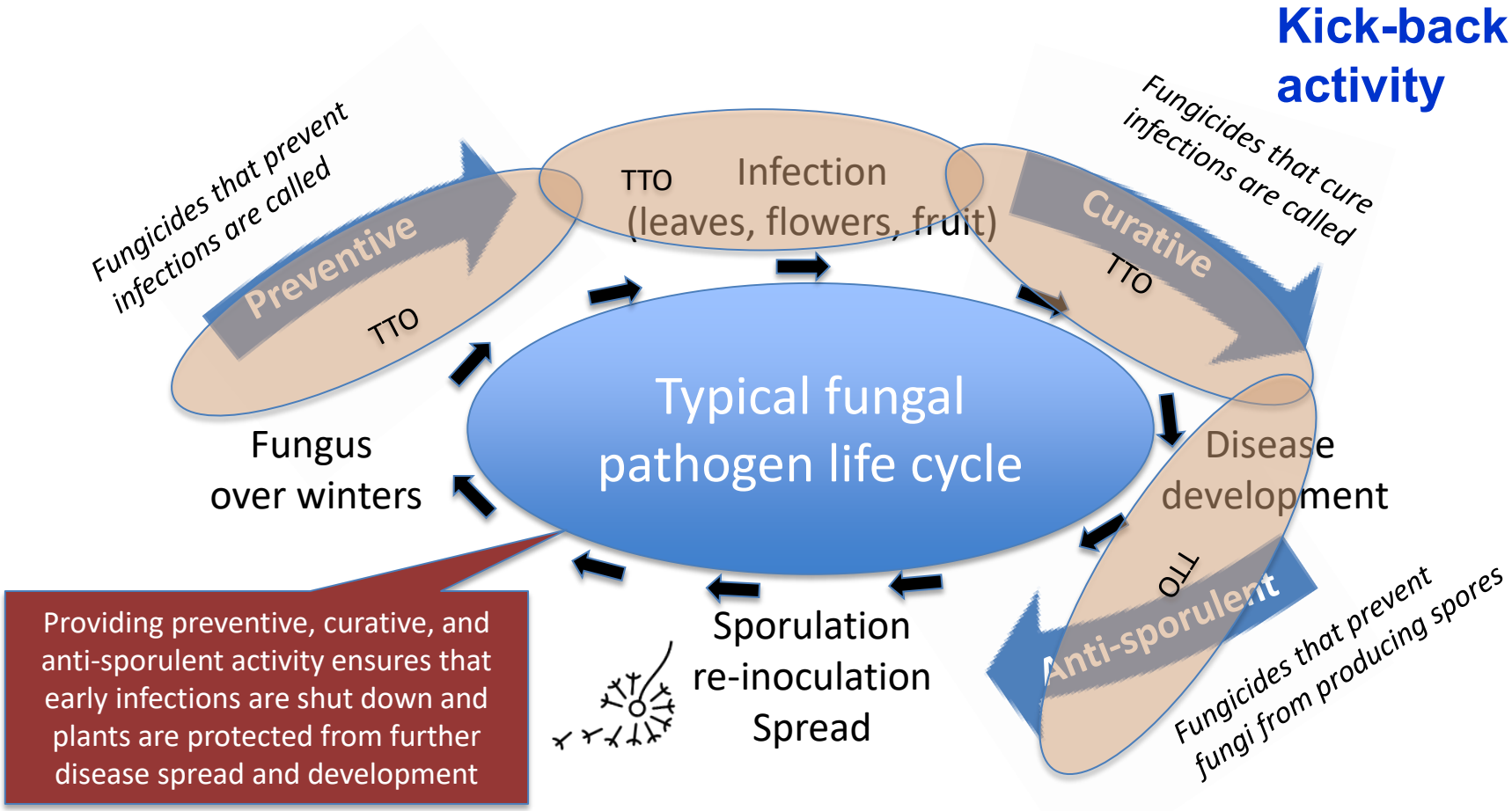
TTO provides preventive, curative, and anti-sporulan activity



TTO provides preventive, curative, and anti-sporulan activity



TTO provides preventive, curative, and anti-sporulan activity



Spectrum of Activity: Fungal & Bacterial

Bacterial Diseases	Alternaria	Botrytis	Anthracnose	Powdery Mildew
✓✓	✓✓	✓✓✓	✓✓✓	✓✓✓

This is a huge advantage because:

- There aren't many products registered to control bacterial diseases.
- Bacterial diseases can cause significant losses.
- You never know what might come in, so this is a one shot covers all option

Bacterial diseases controlled

Crop	Disease	Pathogen
Berries	Bacterial canker Angular leafspot	Pseudomonas syringae Pseudomonas fragariae
Brassica (cole) leafy veg	Xanthomonas leaf spot	Xanthomonas campestris
Cereals	Bacterial blight & streak	Xanthomonas spp.
Citrus fruits	Bacterial blast Bacterial canker	Pseudomonas syringae Xanthomonas spp.
Coffee	Bacterial blight	Pseudomonas spp.
Fruiting veg	Bacterial blight Bacterial speck Bacterial spot Bacterial canker	Xanthomonas spp. Pseudomonas syringae Xanthomonas spp. Clavibacter michiganensis

Crop	Disease	Pathogen
Leafy veg	Bacterial blight Bacterial leaf spot	Xanthomonas spp. Pseudomonas syringae
Legume veg	Bacterial pustule	Xanthomonas spp.
Peanut	Bacterial diseases	Pseudomonas solanacearum
Root & tuber veg	Bacterial leaf blight Bacterial leaf spot Bacterial soft rot	Xanthomonas campestris Xanthomonas spp. Erwinia carotovora
Tree nuts	Bacterial canker	Pesudomonas syringae
Tropical & sub-tropical fruit	Bacterial blight Bacterial canker	Pseudomonas syringae Xanthomonas campestris

Pseudomonas
Xanthomonas
Clavibacter
Erwinia

Please see the TIMOREX ACT label for a complete list of crops and diseases

Disease Spectrum (Abbreviated)

Fungal

- Alternaria
- Anthracnose
- Ascochyta Blight
- Asian Soybean Rust
- Black Mold
- Botrytis
- Cercospora Leaf Spot
- Downy Mildew
- Early Blight
- Fruit Rots

Fungal cont'd

- Leaf Blight
- Leaf Spots
- Phytophthora
- Powdery Mildew
- Pythium
- Rhizoctonia
- Rusts
- Scab
- Sclerotinia

Bacterial

- Blight
- Canker
- Leaf Spot
- Pustule
- Soft Rot
- Speck
- Streak

Please see the TIMOREX ACT label for a complete list of diseases controlled

Broad Range of Crops

- Bananas
- Berries* (CG 13-07)
- Citrus (CG 10-10)
- Bulb Vegetables (CG 3-09)
- Cereal Grains (CG 15)
- Hops
- Cucurbits* (CG 9)
- Fruiting Vegetables* (CG 8-1)
- Grass Seed Production Crops
- Leafy Vegetables* (CG 4-16)
- Legume Vegetables (CG 6)
- Peanuts
- Pomegranate
- Root & Tuber Vegetables (CG 1)
- Tree Nuts (CG 14-12)
- Inedible Peel Tropical & Subtropical Fruit (CG 24)
- Coffee

* Including greenhouse crops

FRAC Reclassification of TTO

TIMOREX ACT ADVANCED NATURAL PLANT DISEASE CONTROL

OMRI LISTED For Organic Use

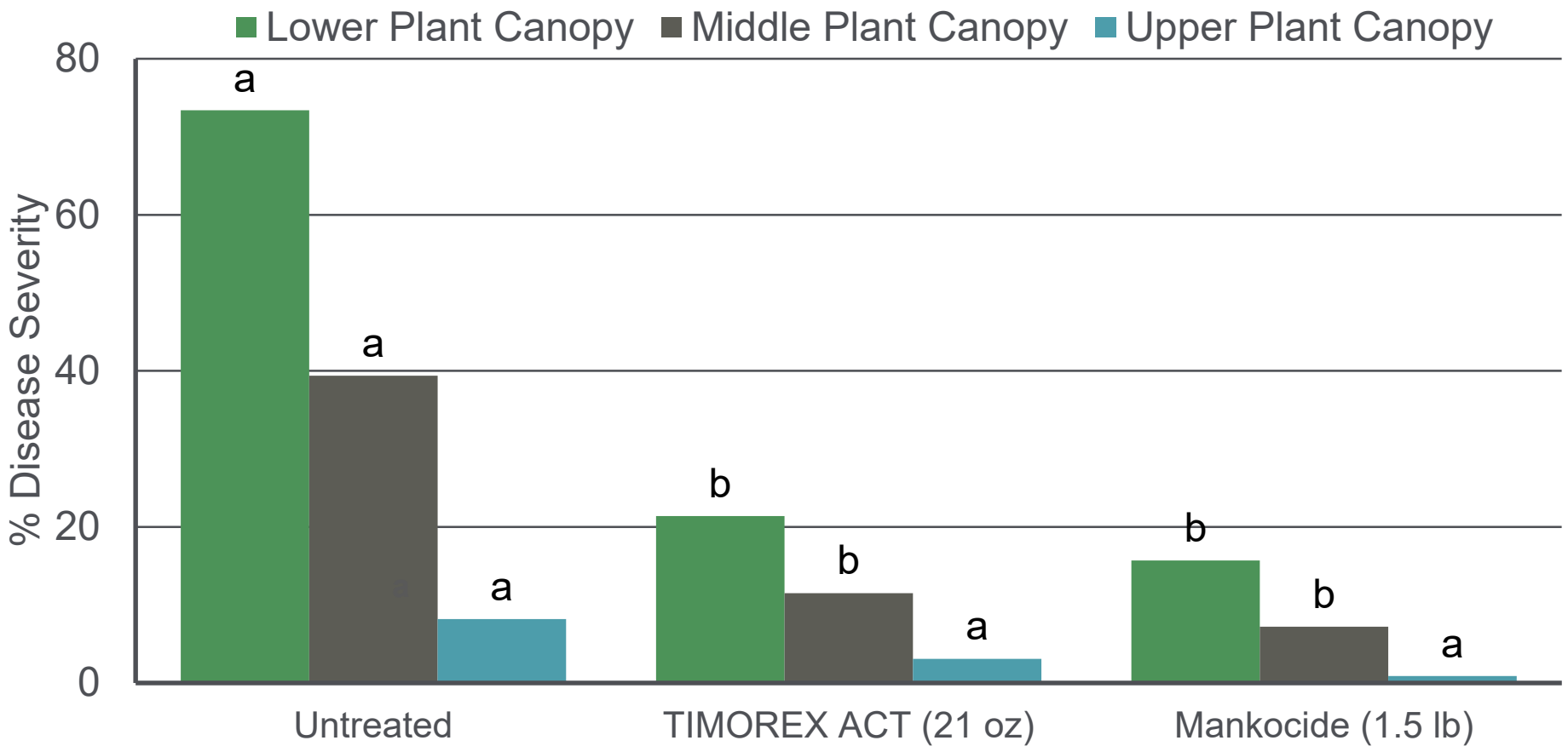
Group BM01

A.I.	TARGET SITE & CODE	GROUP NAME	CHEMICAL GROUP	COMMON NAME	COMMENTS	FRAC Group
TTO	cell membrane disruption, cell wall Induced plant defense mechanisms	plant extracts	terpene hydrocarbons, terpene alcohols and terpene phenols	extract from *Melaleuca alternifolia* (tea tree) plant oils (mixtures): eugenol, geraniol, thymol	Resistance not known (previously F7)	BM01

FRAC FUNGICIDE RESISTANCE ACTION COMMITTEE

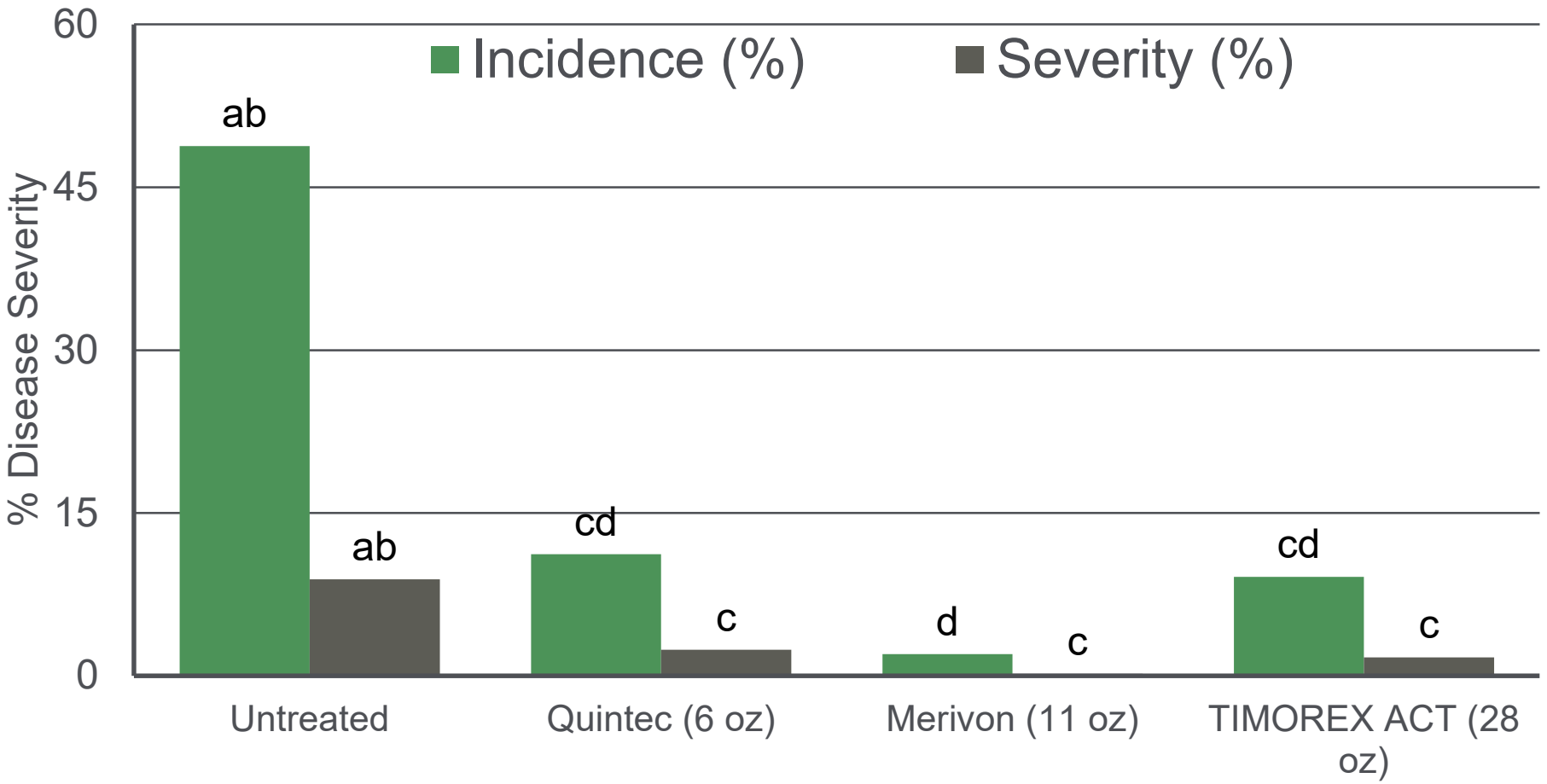
- TTO was recently reclassified by FACT from Group 46 to Group **BM01**
- BM01 is seen as a low risk for resistance category

Bacterial Spot Control on Tomato



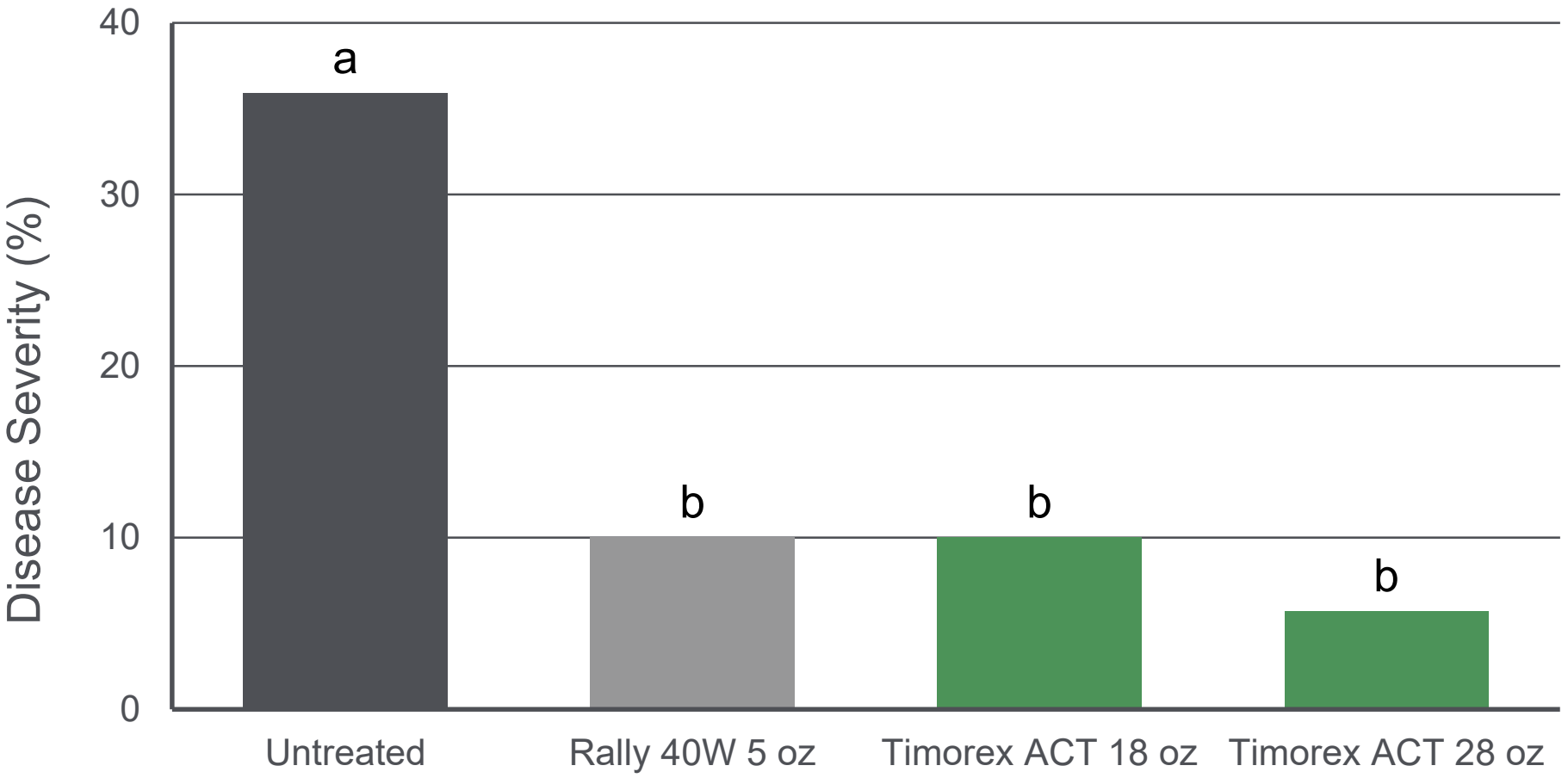
GLC Consulting | 2017 | Quitman, GA | Bacterial spot: *Xanthomonas euvesicatoria* | RCB: 7 reps; 6 apps

Powdery Mildew Control on Strawberry



Cal Poly Strawberry Center | San Luis Obispo, CA | 2018
First app: Feb 21 | First rating: 6 days after first spray | RCB: 4 reps; assessments on Mar 20

Downy Mildew Control on Broccoli



Blaine Turner | Yuba City, CA | 2018 | Pathogen: *Hyaloperonospora brassicae* | 2 apps; 7 day schedule; 30 GPA

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