

**Volatile Organic Compounds (VOCs)
from *Trichoderma*:
Their Impact on Plant Growth and Development**

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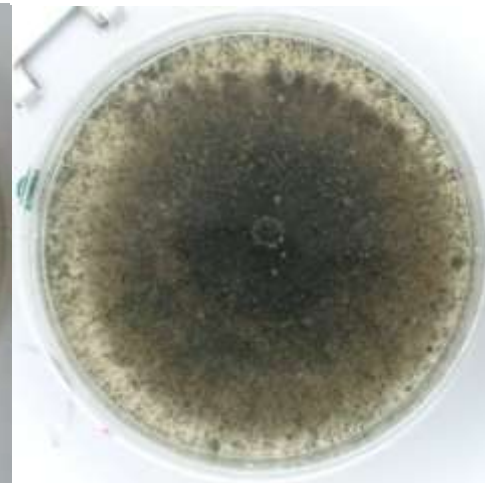
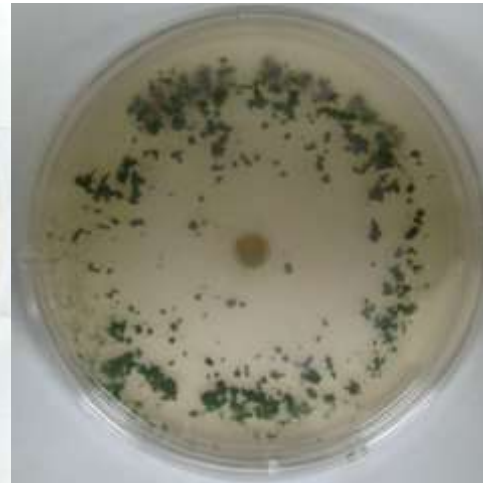
Plant Biology and Pathology

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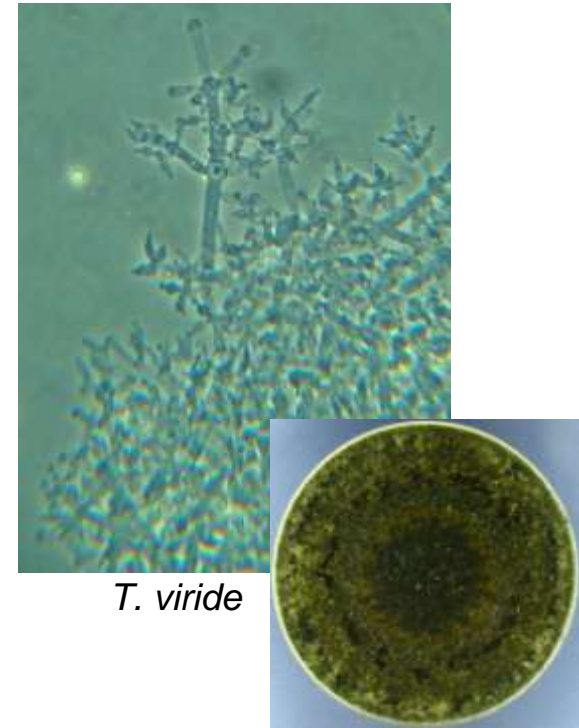
Trichoderma

- Free-living soil fungi
- Commonly isolated in the environment
 - Wide range of climates
- Common in rhizosphere
- Colonize woody and herbaceous plant



Effects of *Trichoderma* on Plants

- Ability promote plant health and growth
 - aid in nutrient uptake
 - efficient nitrogen usage
 - solubilize nutrients in soil
 - improve seed germination
 - ameliorate abiotic and physiological stresses
- Reduce plant disease
 - Antibiosis: produce antibiotic substances
 - Mycoparasitism: parasitize pathogens
 - Produce elicitors or activate pathways → increase systemic resistance
 - Small protein 1: produce ROS = increase defense related genes
 - Activate jasmonate salicylate and ethylene signaling pathways



T. viride

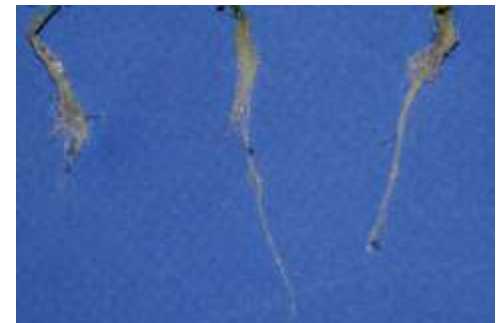
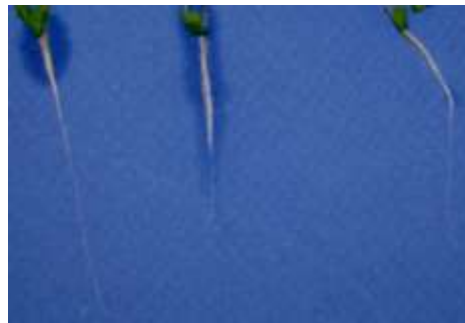
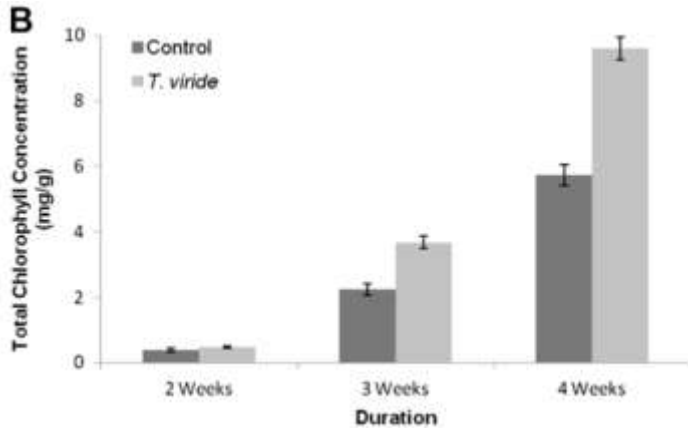
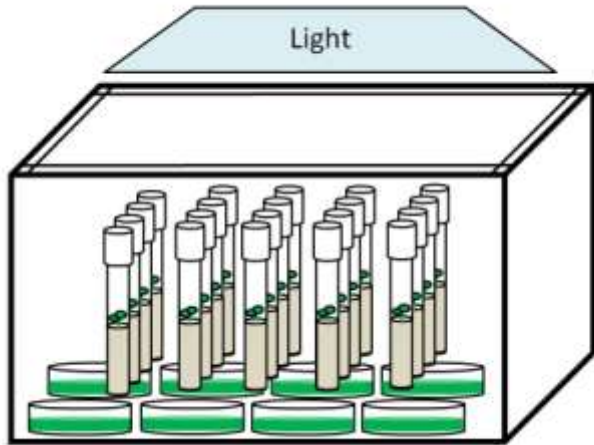
Trichoderma VOCs: Wide Range of Compounds

- > 150 unique compounds identified

<i>Trichoderma</i> VOCs	
Hydrocarbons	Alkanes, dienes, trienes
Terpenes	Hemi-(C5), mono-(C10), sesqui-(C15, C11, C12), di-(C20) Hydrocarbons, alcohols, ketones
Alcohols	Saturated, unsaturated, branched
Carboxylic acids and esters	Saturated, unsaturated, branched, diols, ketols
Ketones	Saturated, branched, unsaturated, cyclic
Sulfur derivatives	Thiols, mono-, di-, trisulfides, s-methyl thioesters, thioesters
Aromatic compounds	Hydrocarbons, alcohols, ethers, ketones, phenols
Heterocyclics	N – alkyl, alkoxy pyrazines, indoles, pyrroles O – alkyl furans, γ -lactones

T. atroviride, *T. aureoviride*, *T. harzianum*, *T. longibrachiatum*, *T. pseudokoningii*, *T. viride*

Trichoderma VOCs induce plant growth promotion

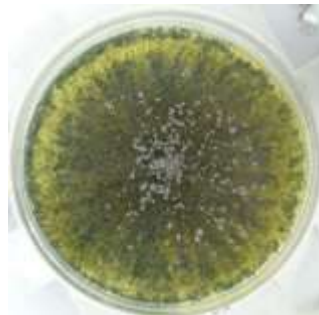


Control

Trichoderma viride VOCs

Investigating VOC-Mediated Interaction

- *T. aggressivum*
- *T. asperellum*
- *T. atroviride*
- *T. brevicompactum*
- *T. harzianum*
- *T. inhamantum*
- *T. koningii*
- *T. longbrachiatum*
- *T. pseudokoningii*
- *T. stromaticum*
- *T. virens*
- *T. viride*



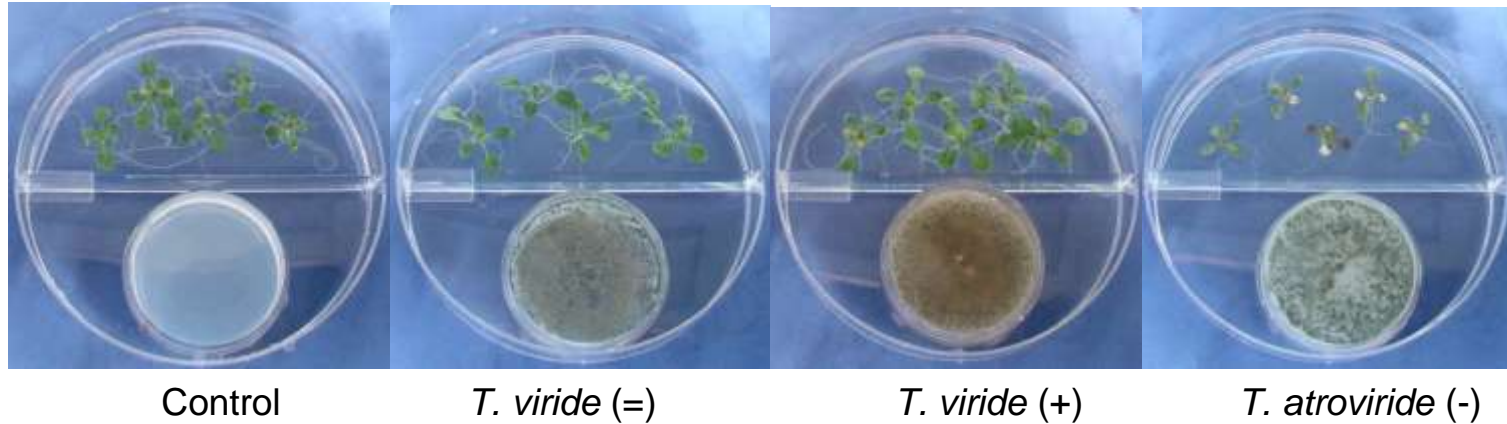
Arabidopsis thaliana

Solanum lycopersicum



22 strains total

**Trichoderma
VOC
Screening**



Method Development
Trichoderma Screening:
 22 *Trichoderma* strains
 (=13 species)

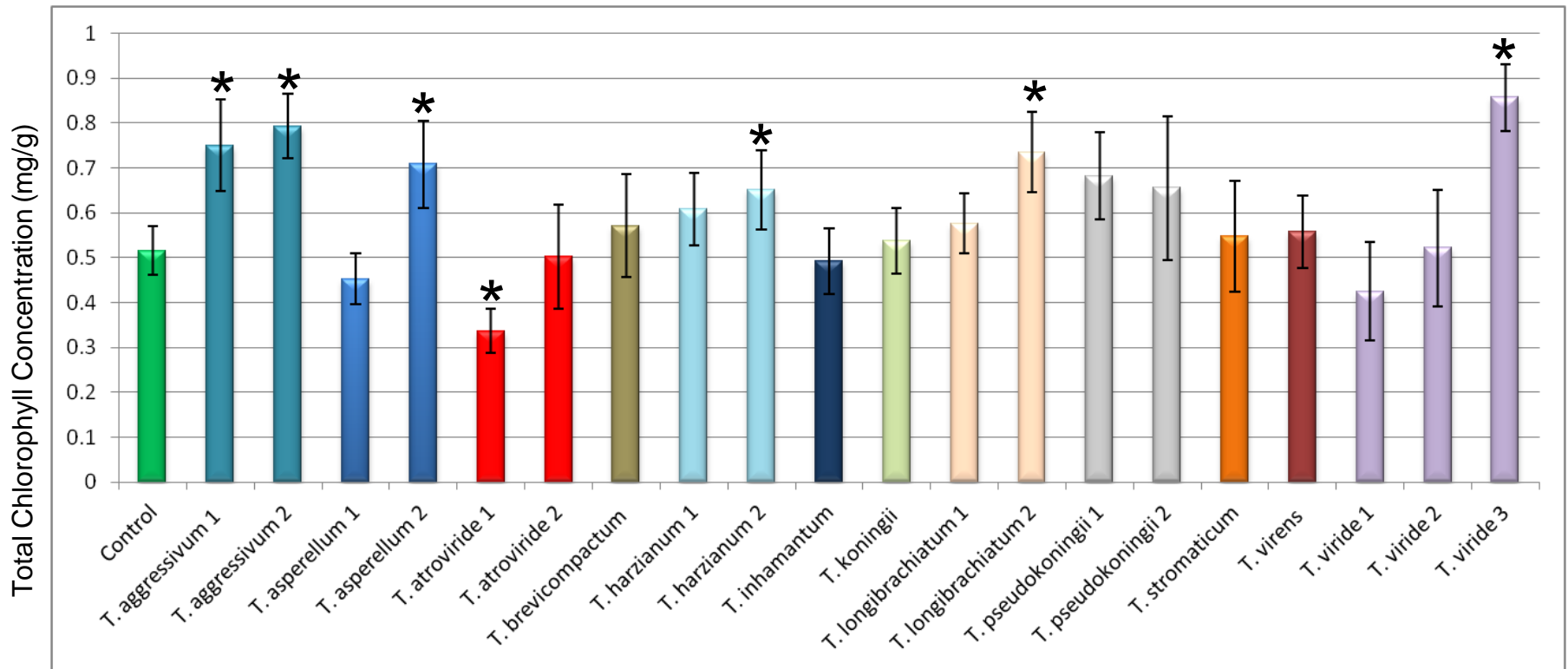
- *Arabidopsis*
- Replicate with tomatoes

**A select few
 induced growth
 promotion**



Arabidopsis thaliana Exposed to Trichoderma VOCs

Duration: 14 Days



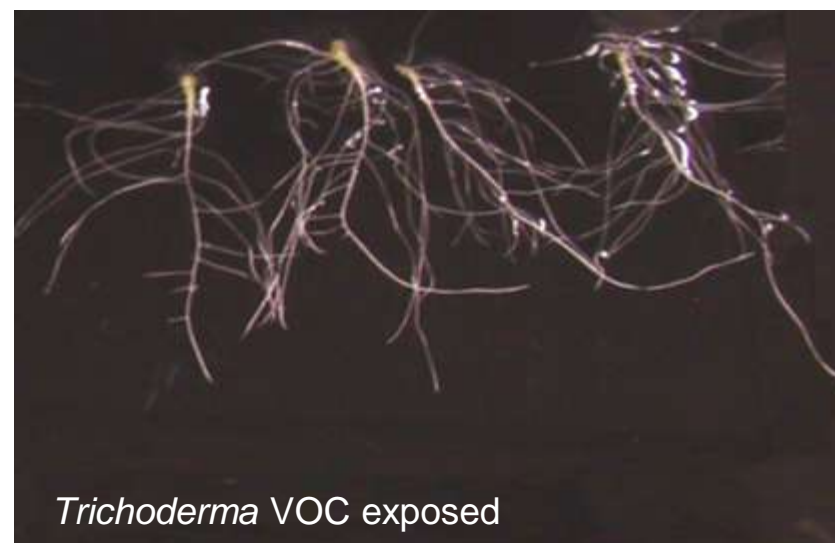
Duration: 14 days
 N = 30
 ANOVA: $P < 0.01$

* Significant

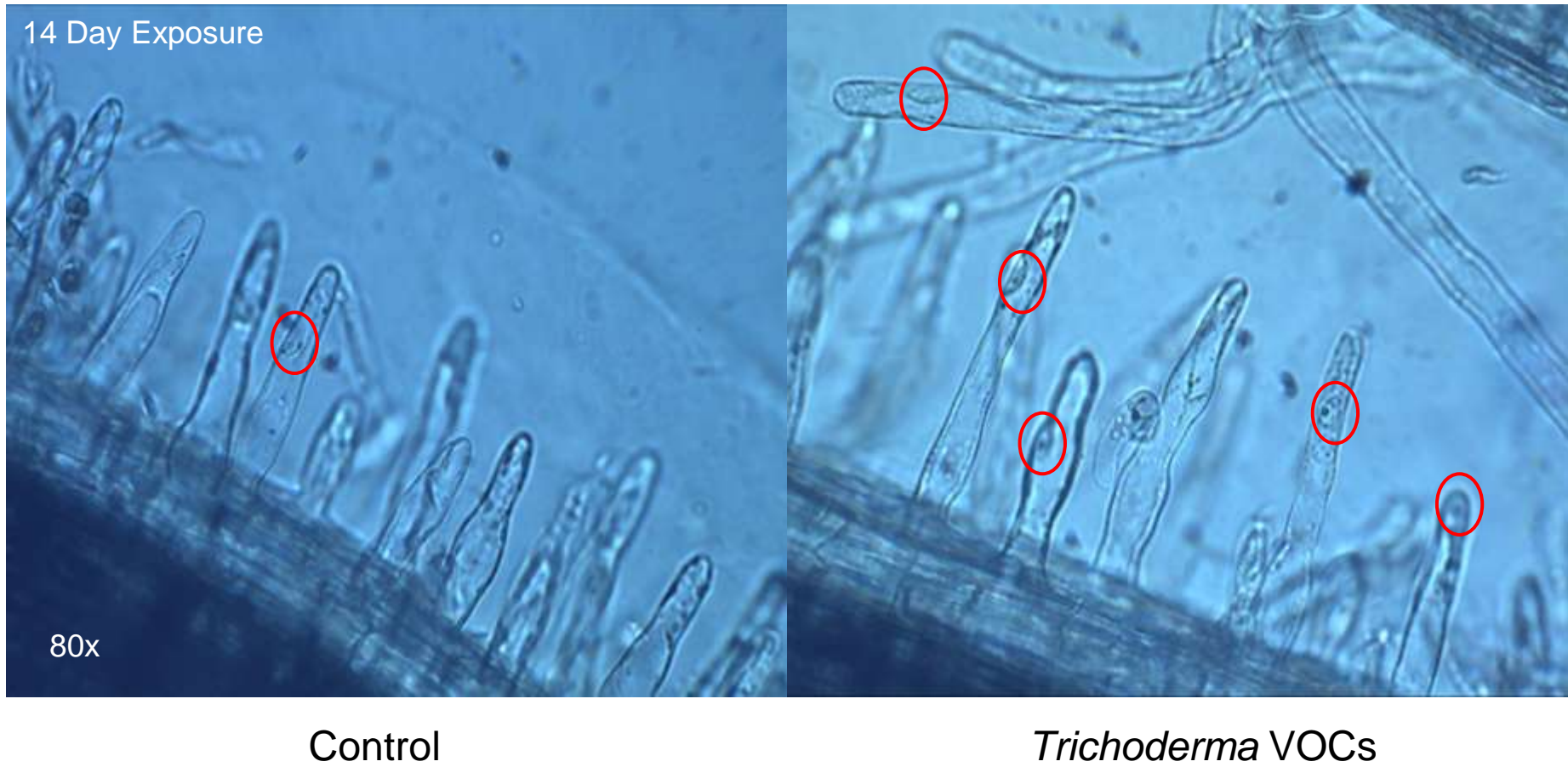
Tomatoes Exposed to *Trichoderma* VOCs



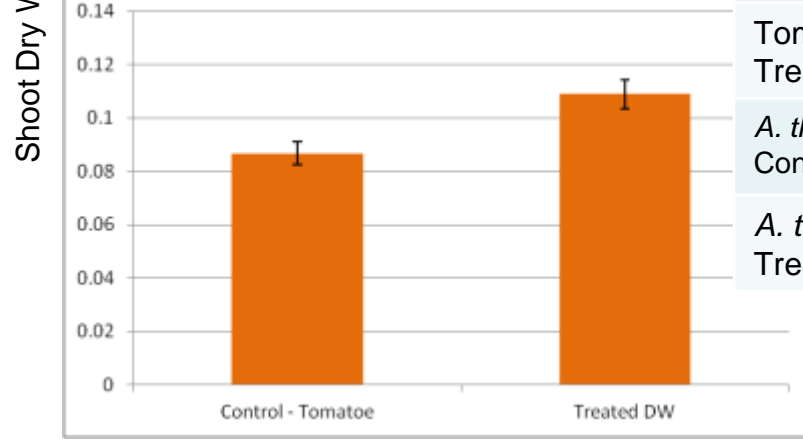
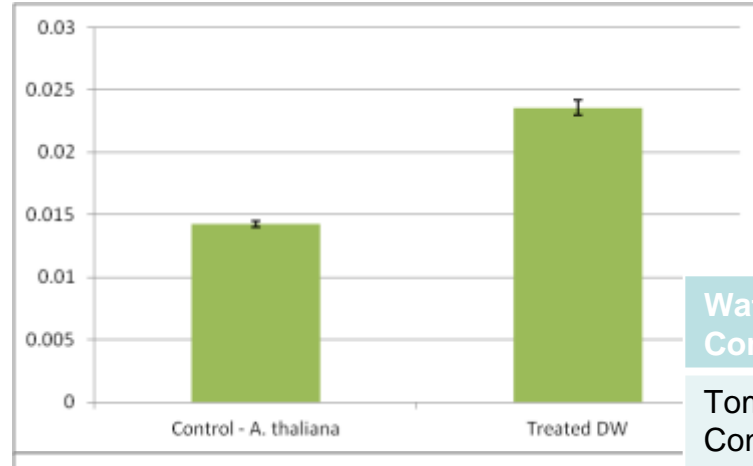
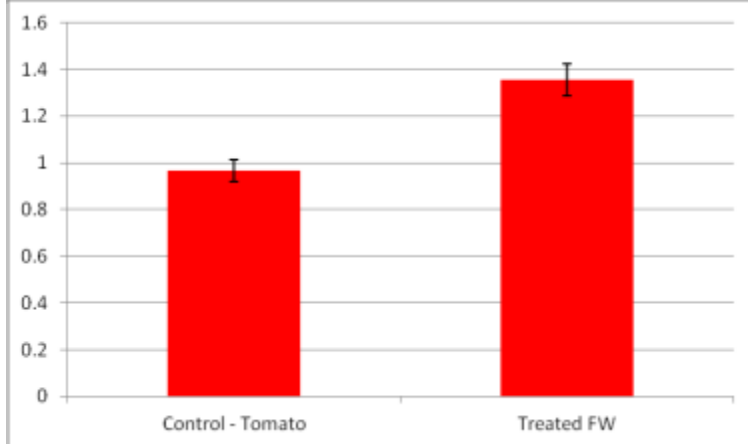
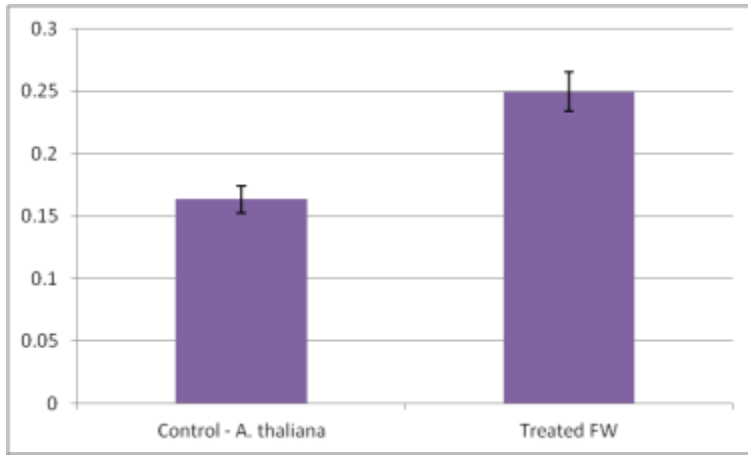
Control

Trichoderma VOCs

Tomato Root Hairs



Relative Water Content Plants Exposed to *Trichoderma* VOCs



Water Content	(%)
Tomato – Control	91.01
Tomato – Treated	91.95
<i>A. thaliana</i> Control	91.25
<i>A. thaliana</i> Treated	90.52

Shoot Fresh Weight (g)

Shoot Dry Weight (g)

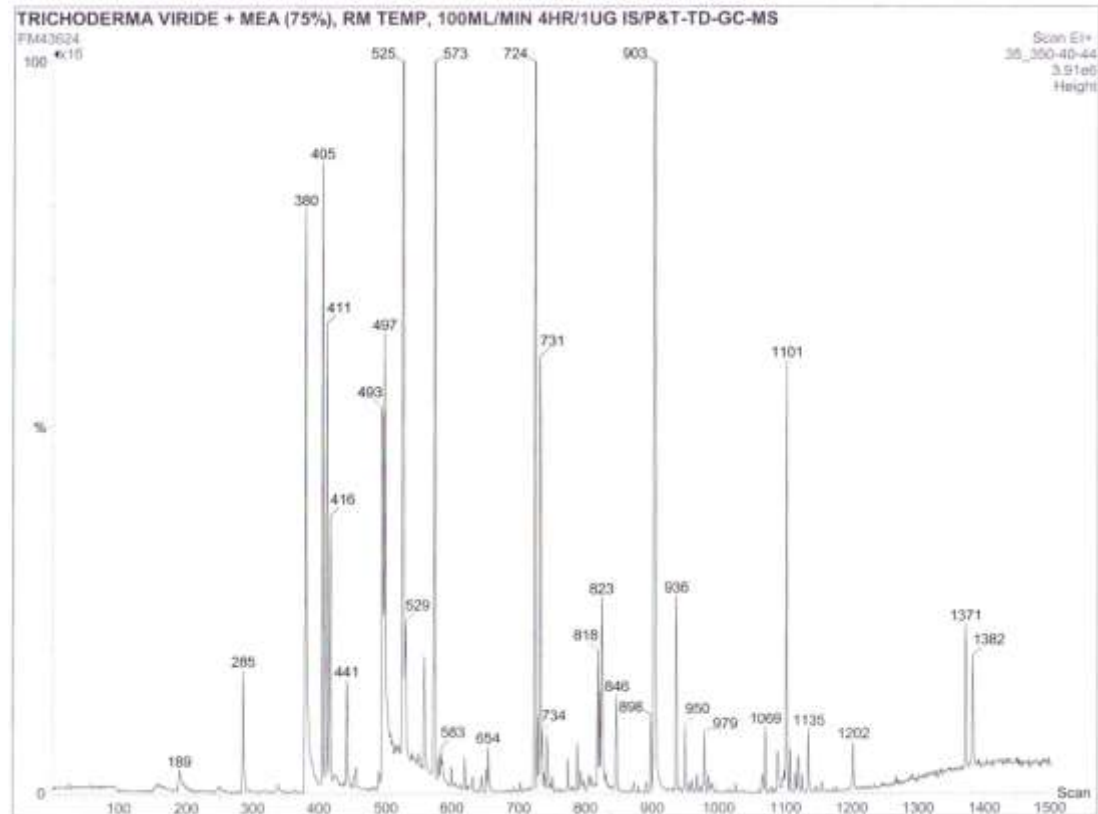
Identify VOCs produced by Trichoderma

Gas chromatography-mass spectrometry (GC-MS)

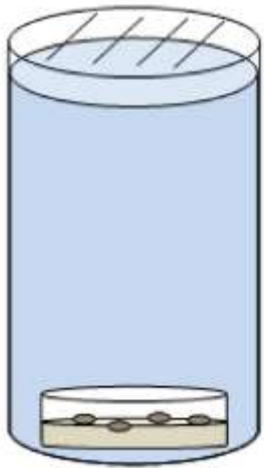
Purge and trap method

GC-MS analysis of
19 *Trichoderma* strains

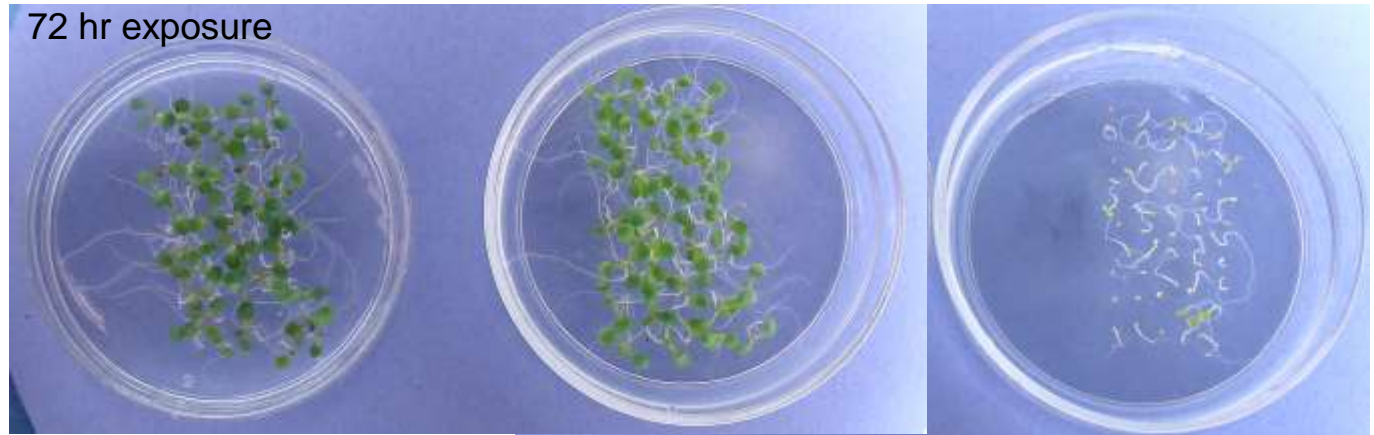
- media control
- in triplicates
- total runs = 60



**Identify compound(s) responsible for plant growth promotion.
Effects on Seed Germination.**



Volatile Exposure Setup



72 hr exposure

Control

1-decene

1-octen-3-ol



No Germination



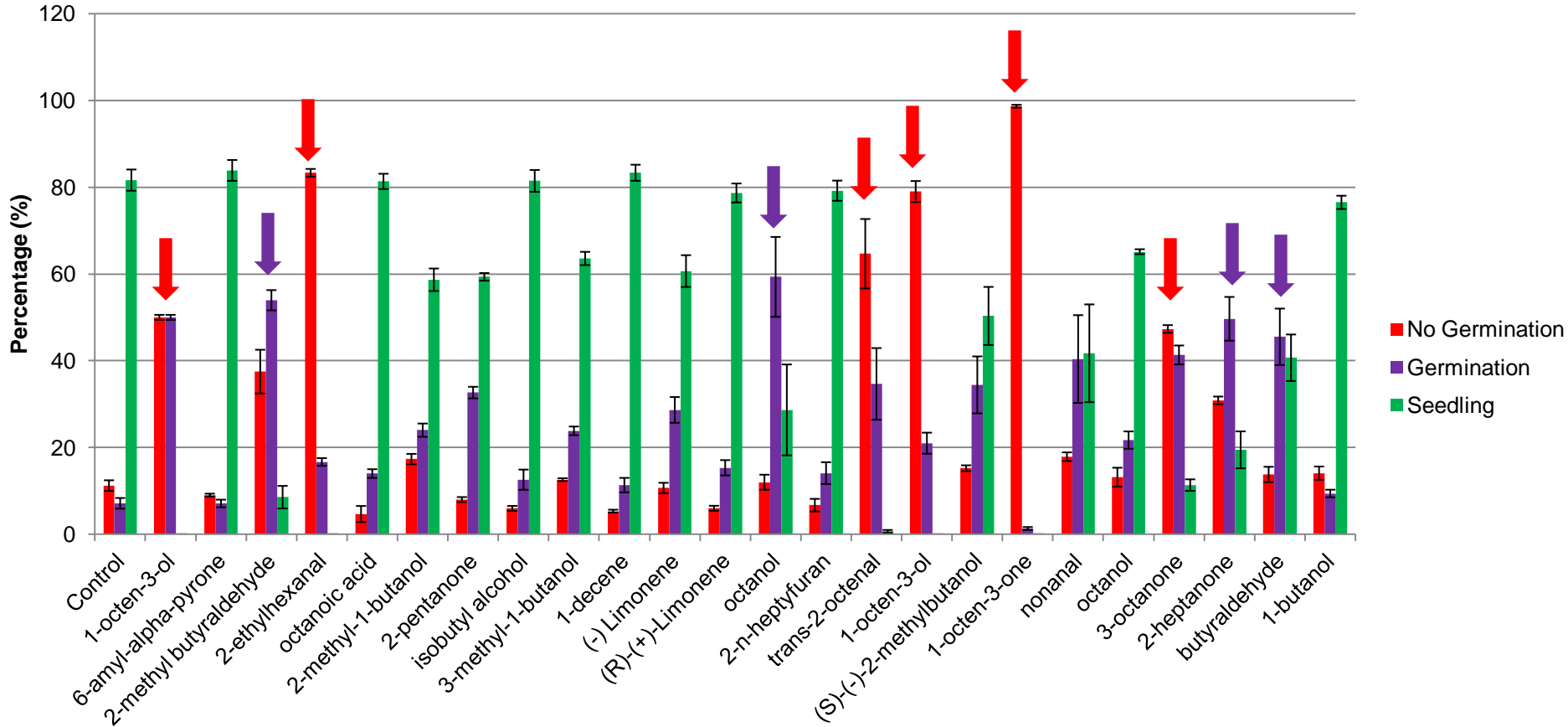
Germination



Seedling

Germination Assay:

72 Hour Exposure to Single Compound (0.5 µg/L)



n = 200

Work Completed

- Microarray
- Relative quantification of auxin-related gene expression
 - Real-time qRT-PCR
 - Indole-3-acetic acid (IAA) Inducible
 - Small auxin upregulated (SAUR)
 - Auxin efflux carrier family (AEC)

Work in Progress

- Test growth promoting compound on tomato seedlings
- Profile transcriptional changes in *Arabidopsis* post volatile treatment: RNA-Seq analysis

Thank You!

Rutgers, Plant Biology and Pathology

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