Recycling solid organic residues from California food processing as soil amendments for biosolarization

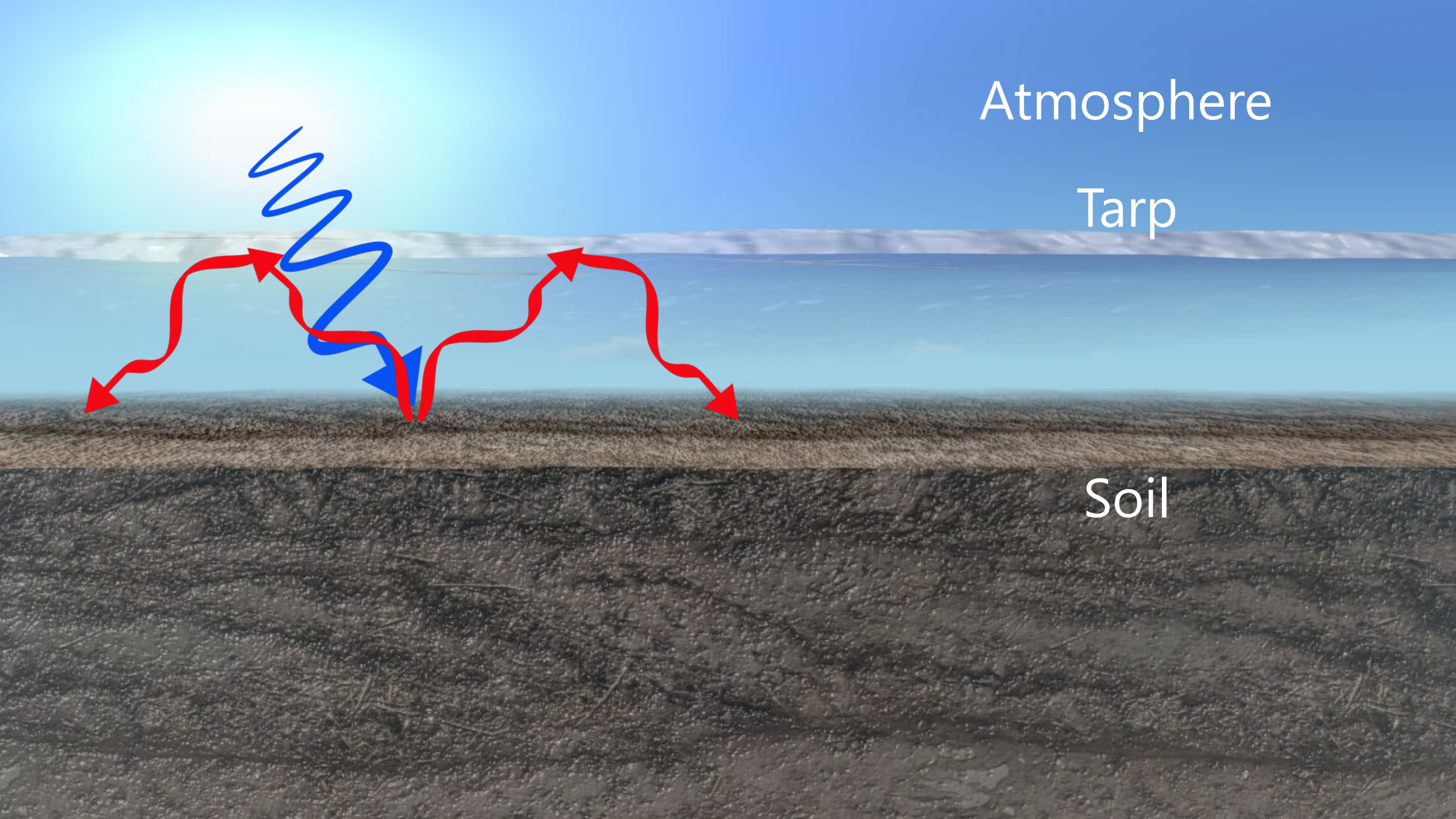
Christopher Simmons
Department of Food Science and Technology

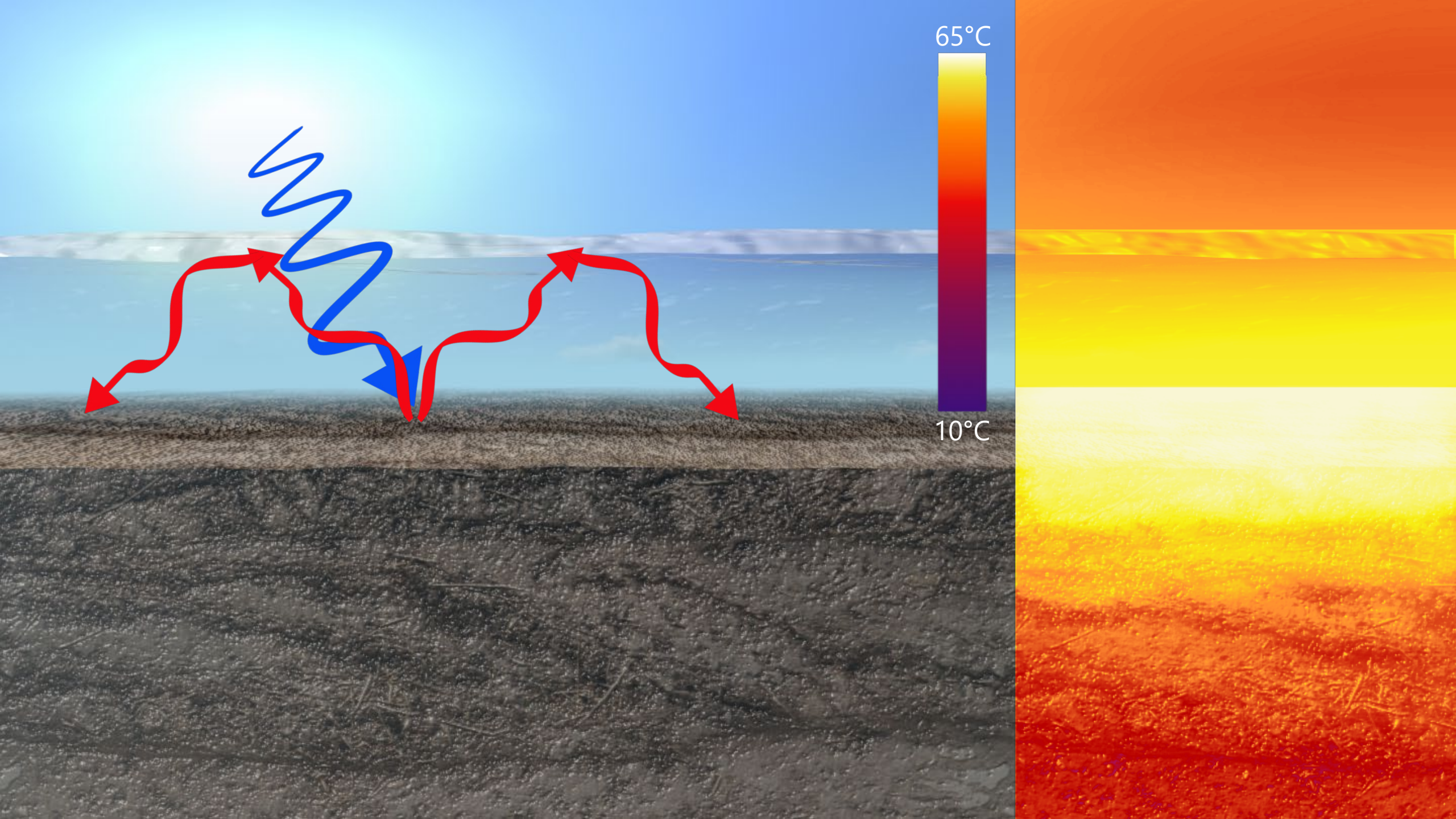
Biosolarization is…

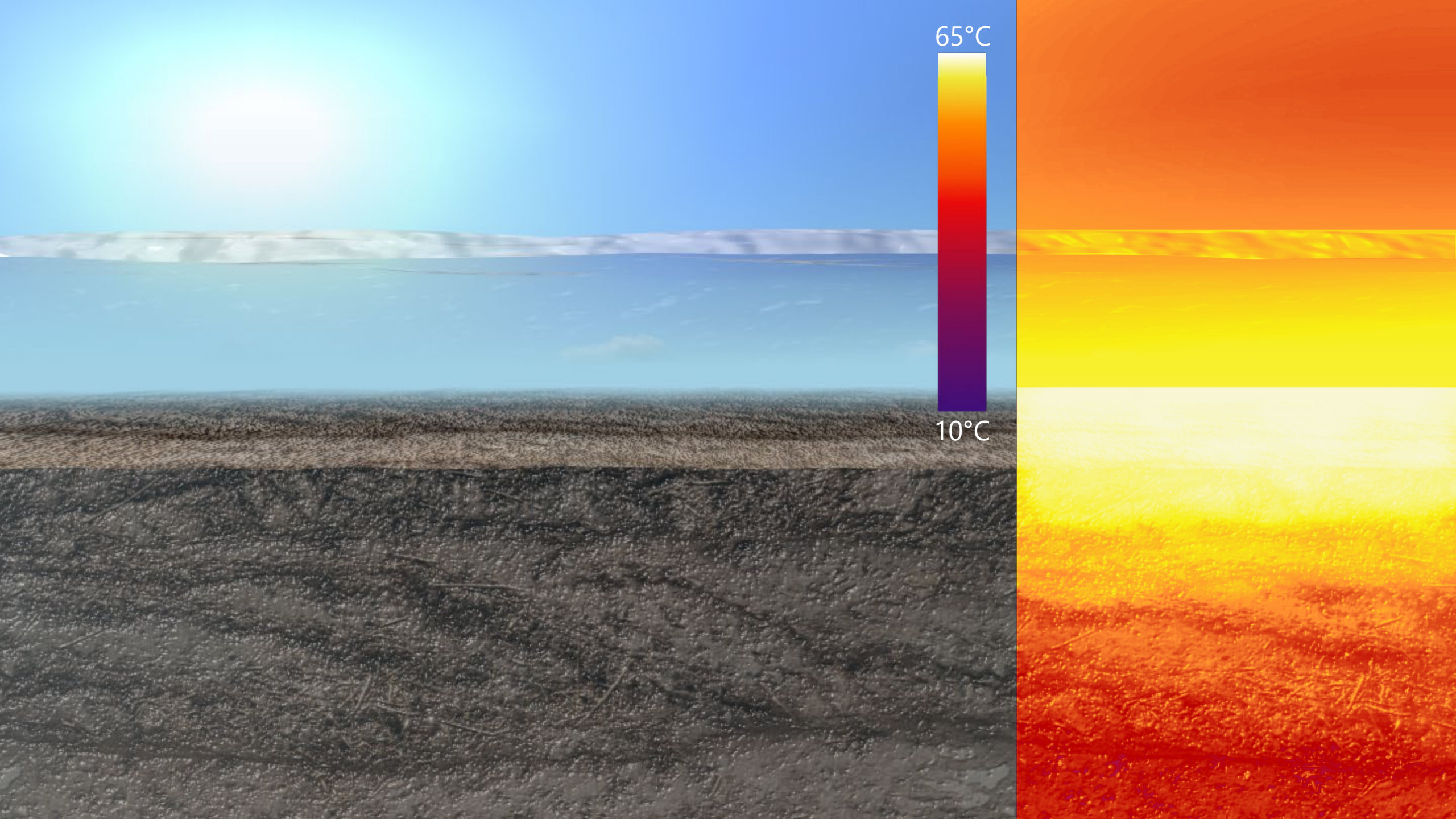
…an alternative to conventional soil fumigation for pest control.

…a circular economy approach to maintaining soil health for food production.


APPLY CLEAR FILM AND
IRRIGATE TO FIELD CAPACITY


Atmosphere
Tarp
Soil


65°C
10°C

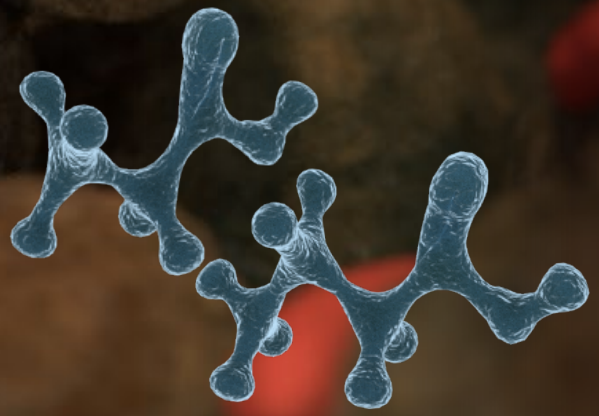

65°C
10°C

BACTERIA PRODUCE BIOPESTICIDES VIA ANAEROBIC FERMENTATION

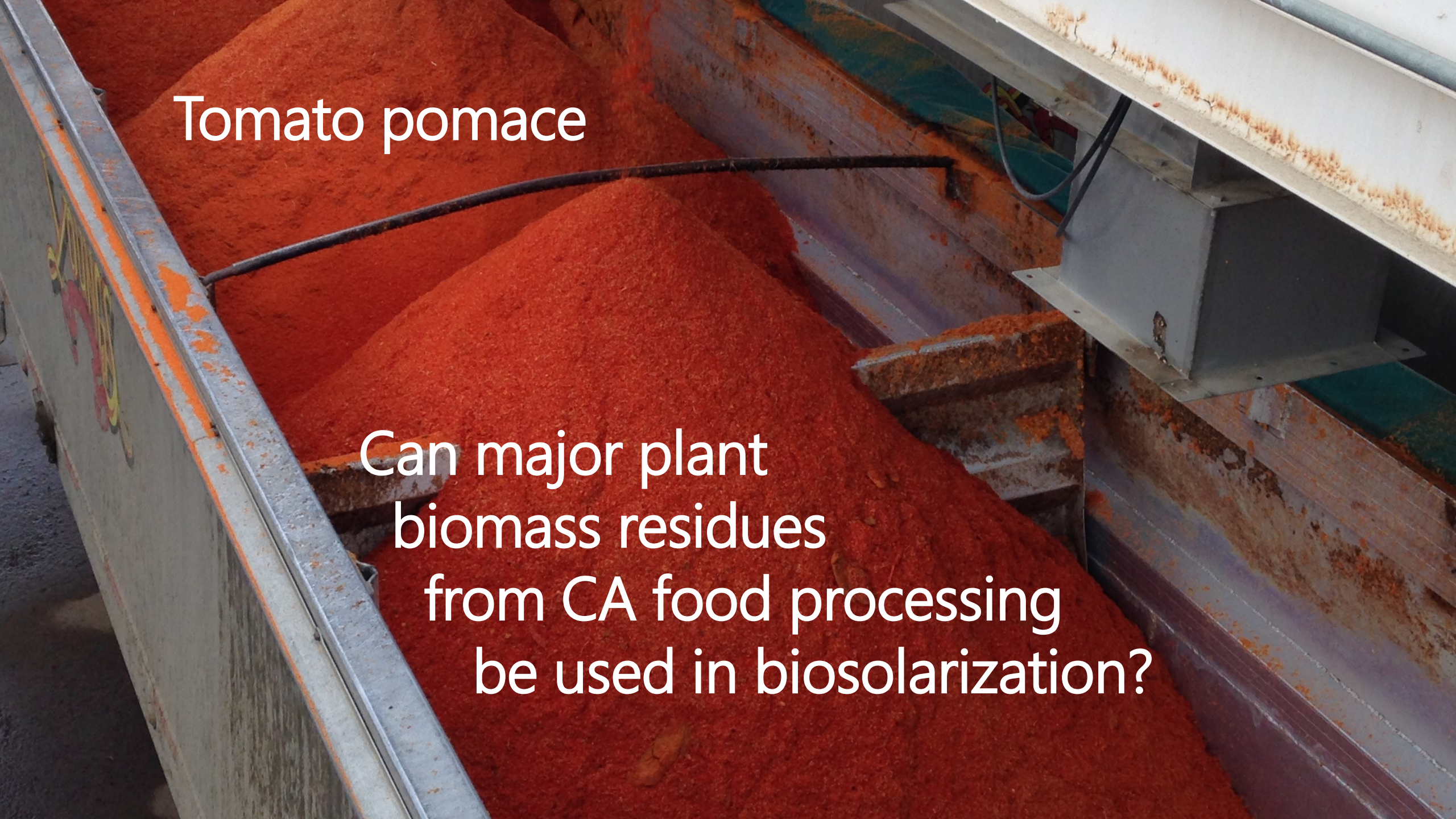
FOR EXAMPLE, ORGANIC ACIDS:

ACETIC ACID

PROPIONIC ACID



BUTYRIC ACID


Tomato pomace
Can major plant
biomass residues
from CA food processing
be used in biosolarization?

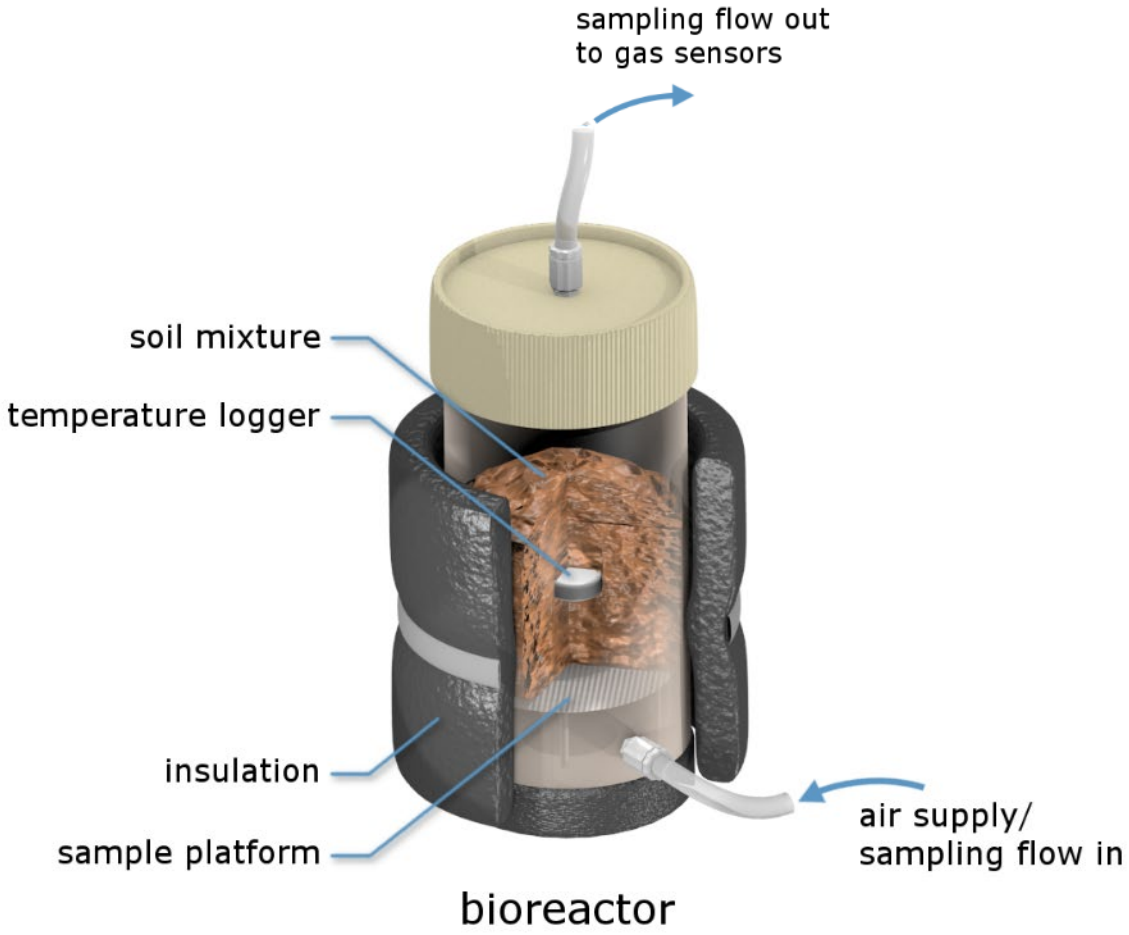
Soil amendments

Field soil

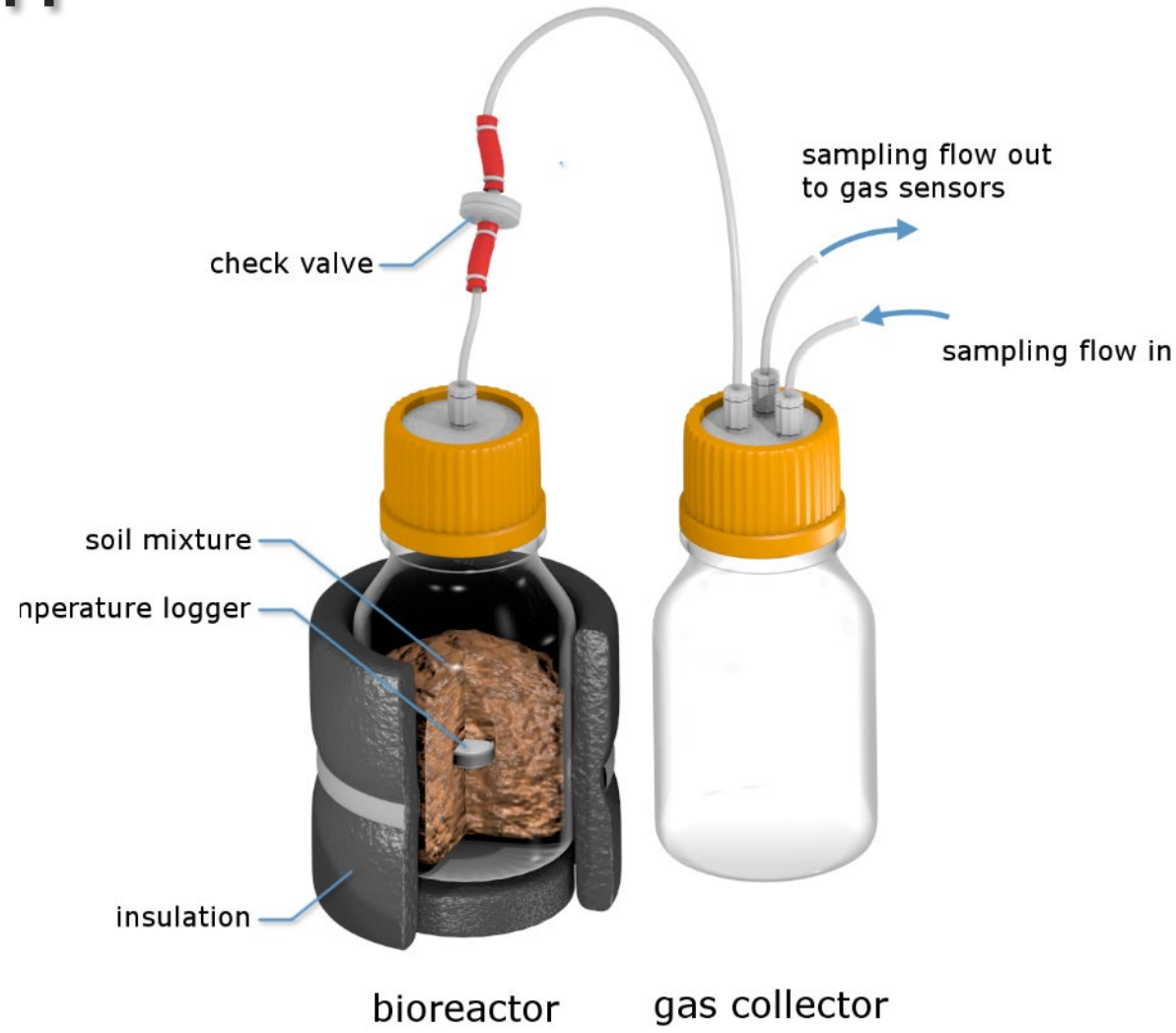
Stable green waste compost, 0-2% dry weight

Tomato pomace, 2.5 to 5% dry weight

Simulated biosolarization



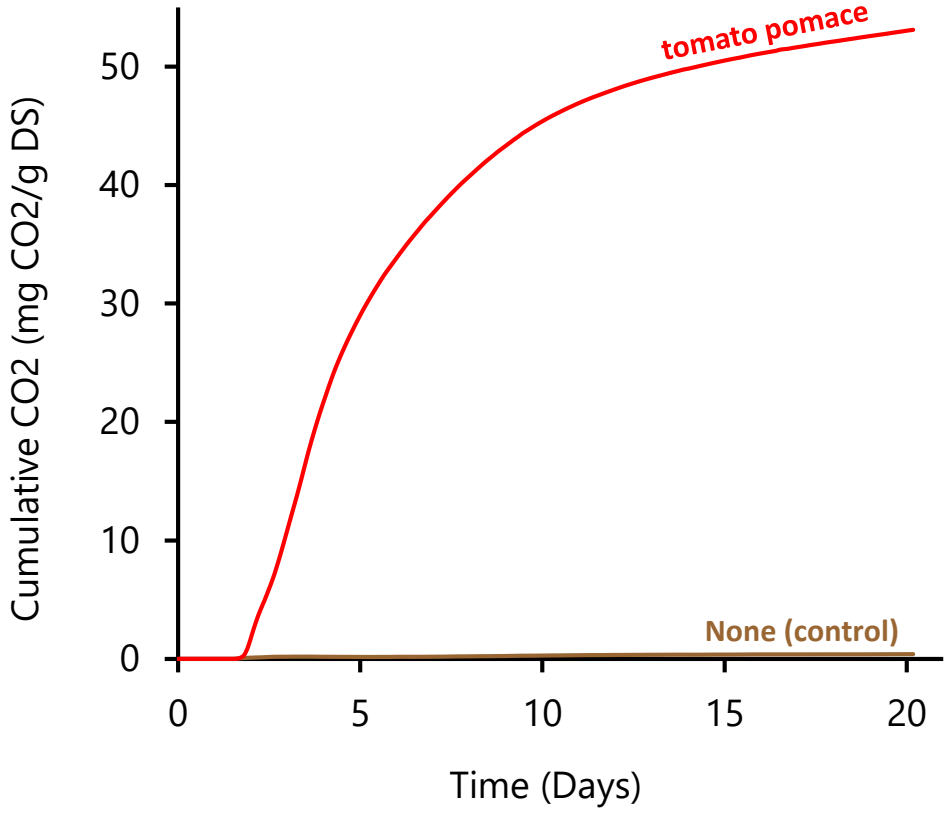
Aerobic conditions, 55 °C



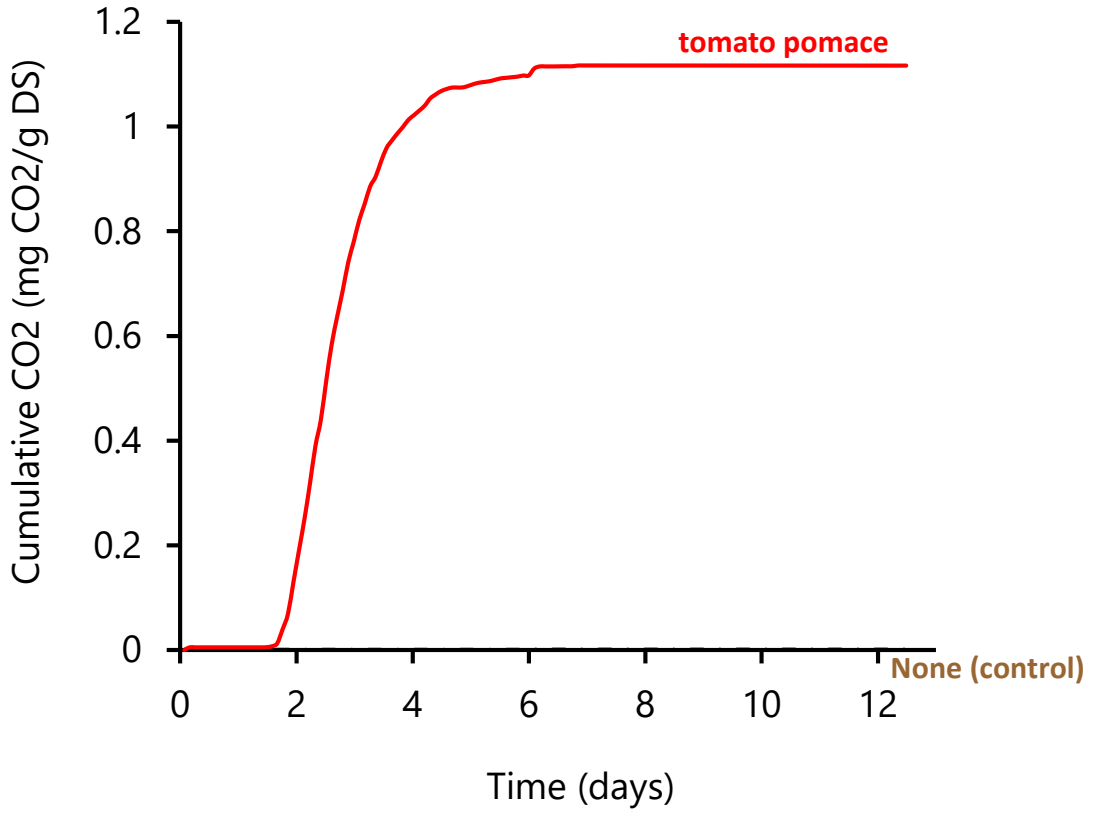
Anaerobic conditions, 55 °C

Simulated biosolarization

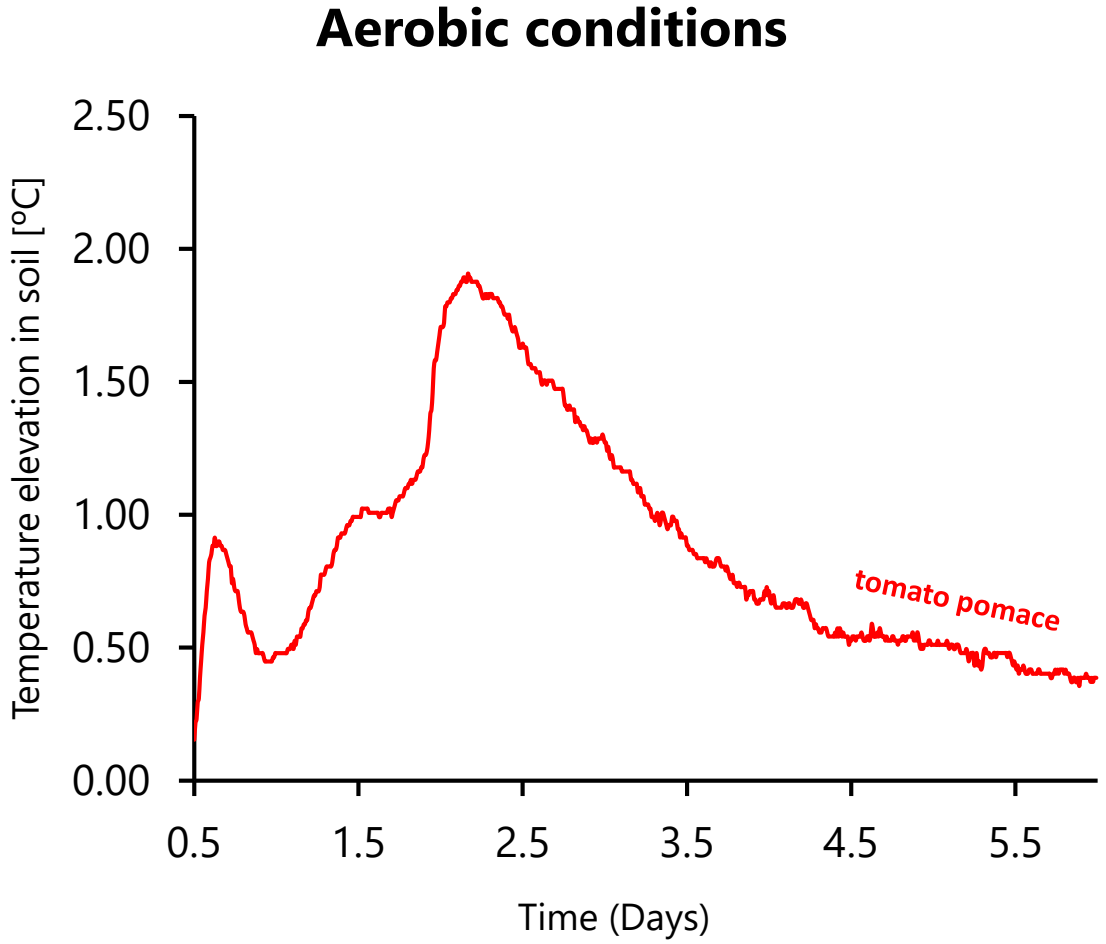
Aerobic conditions, 5% pomace in soil

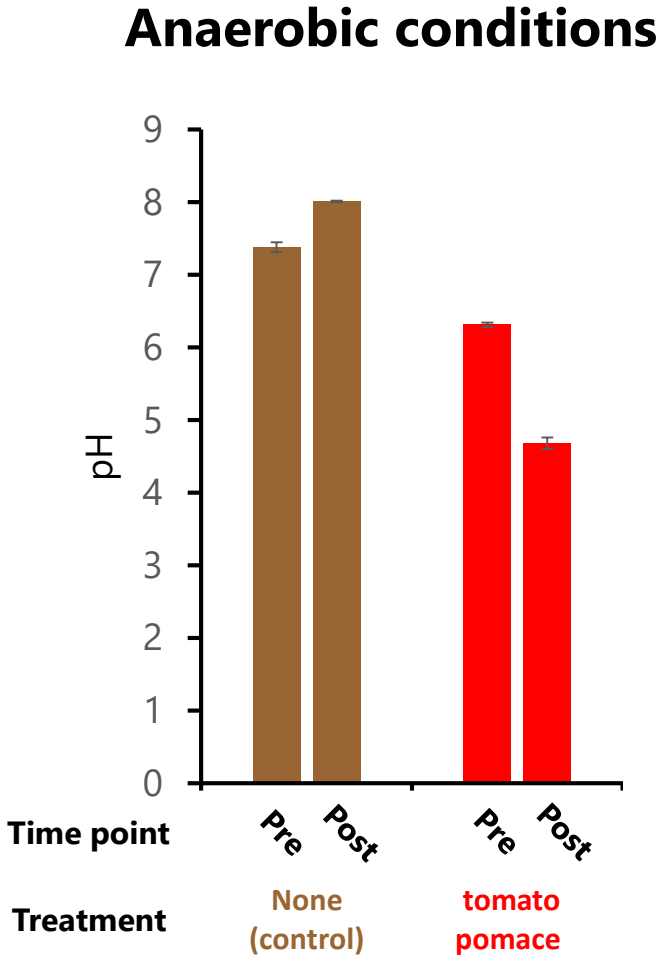


Anaerobic conditions, 5% pomace in soil

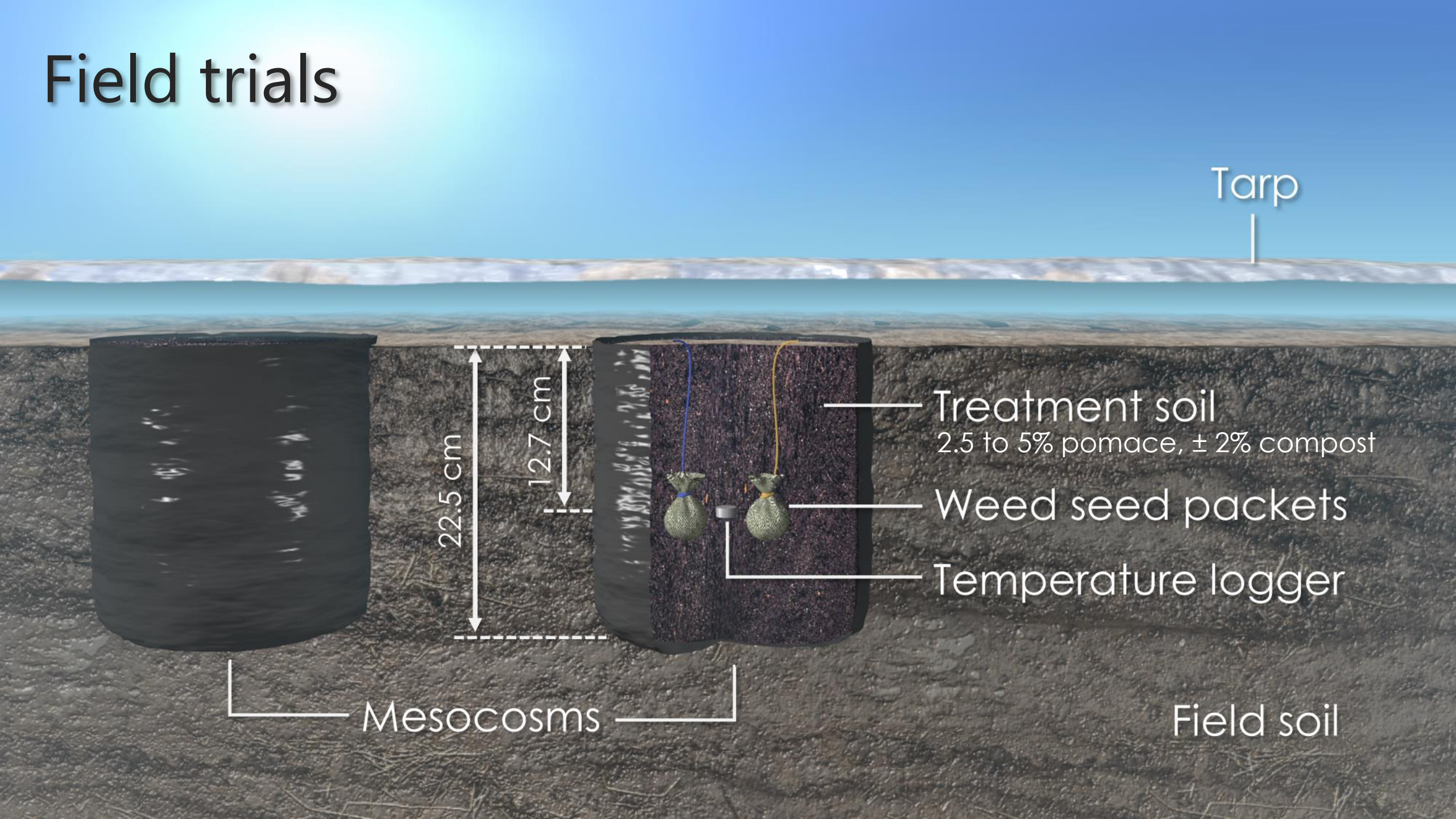


Simulated biosolarization

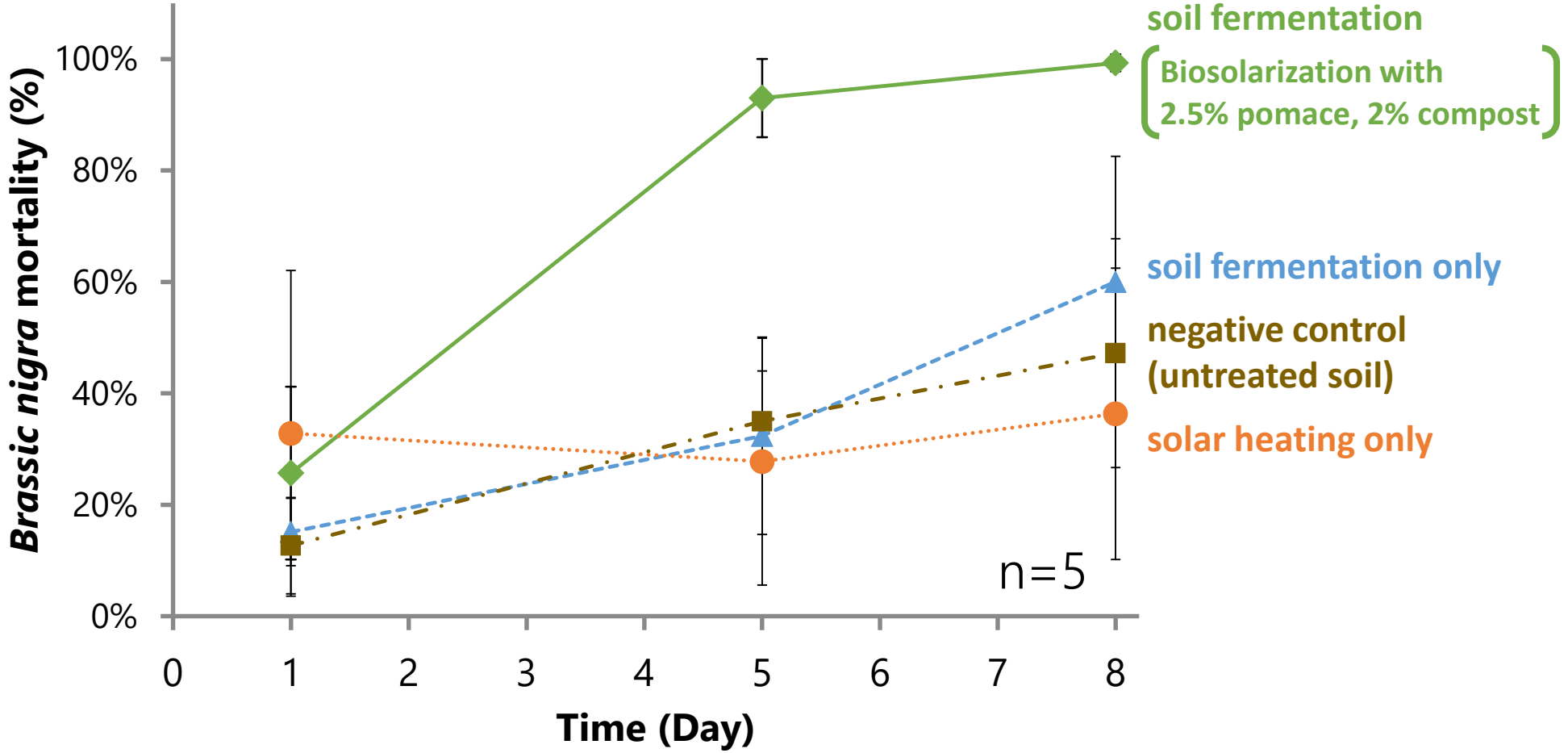




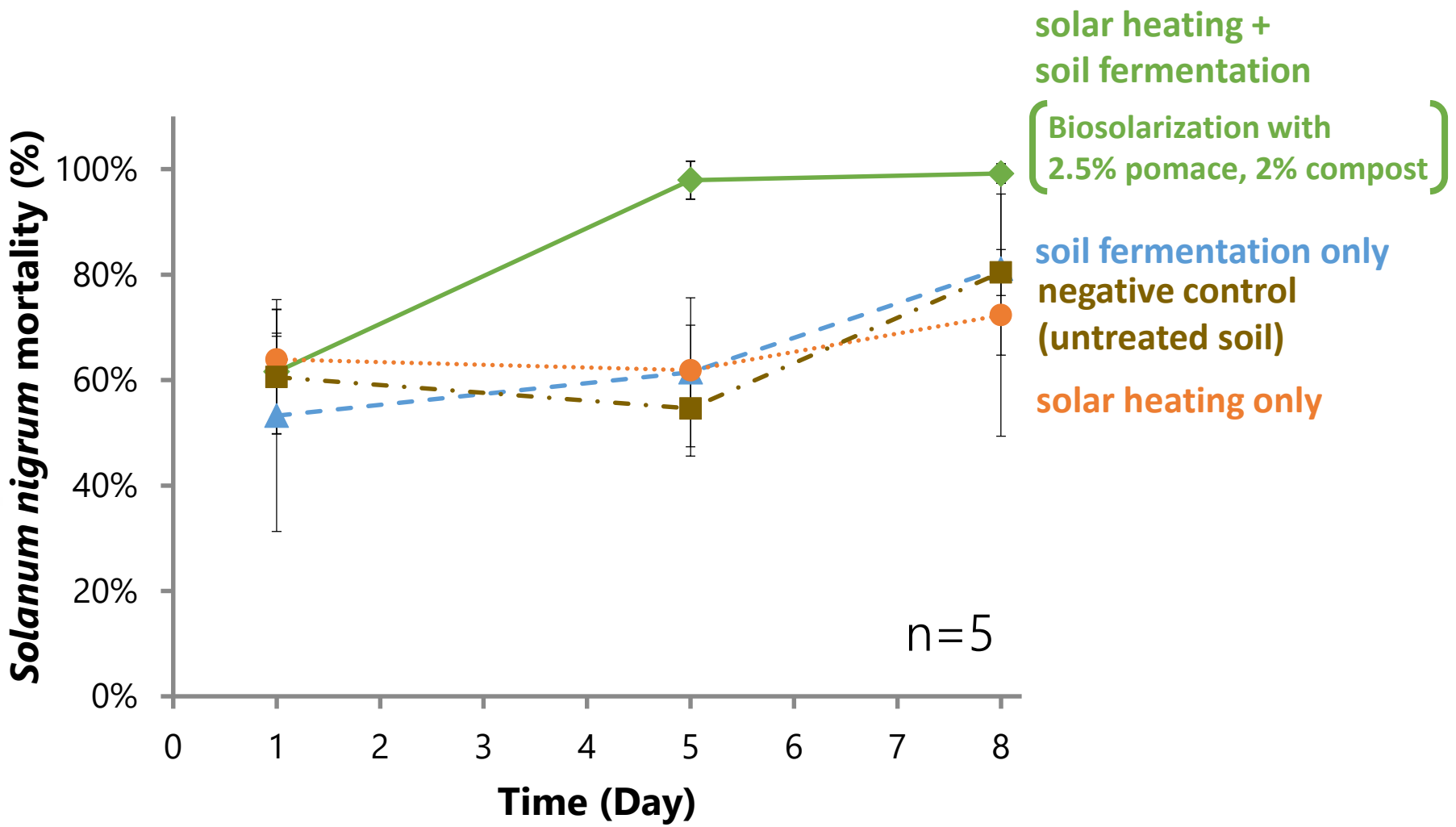
Field trials



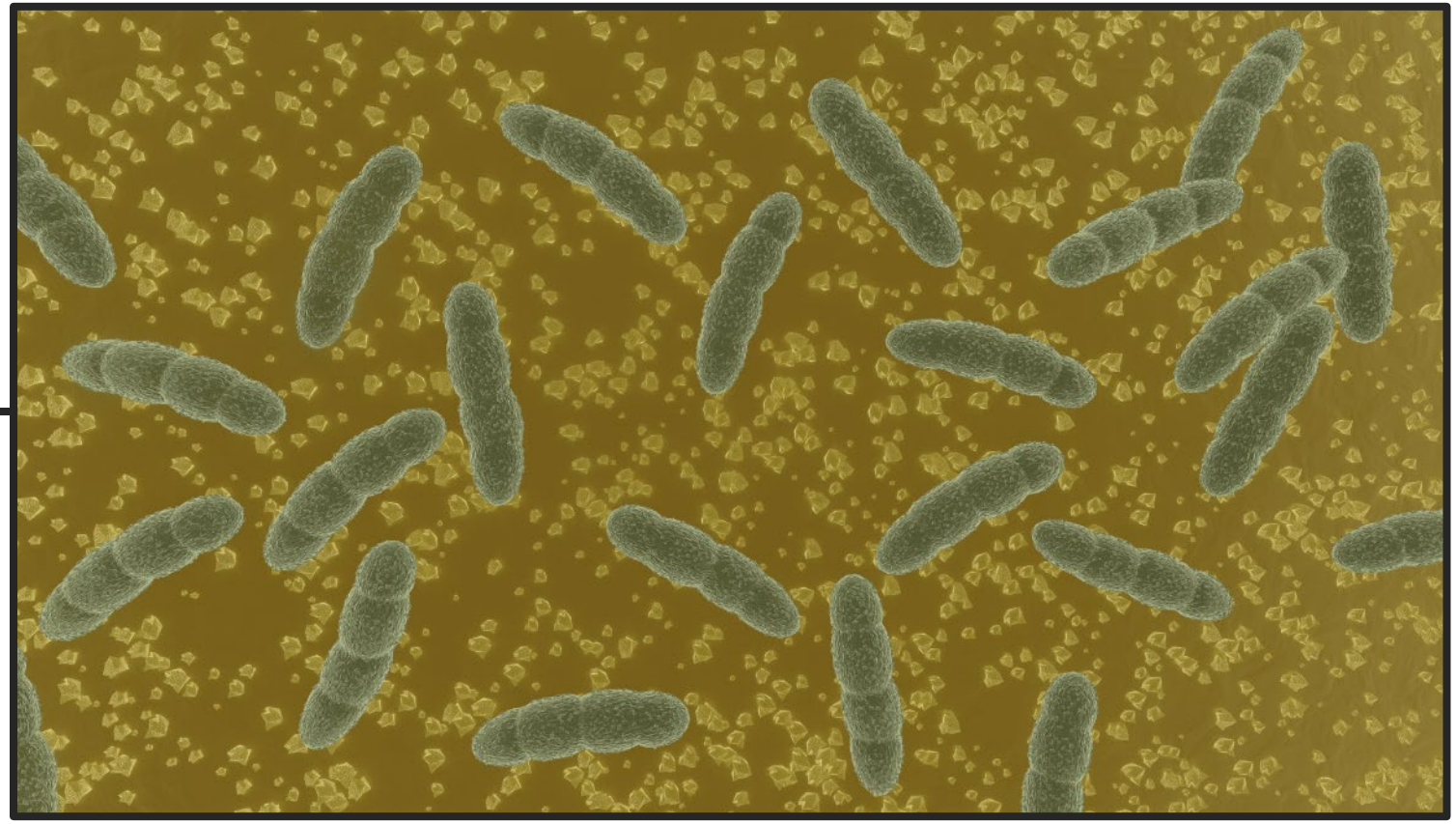
Weed control



Weed control



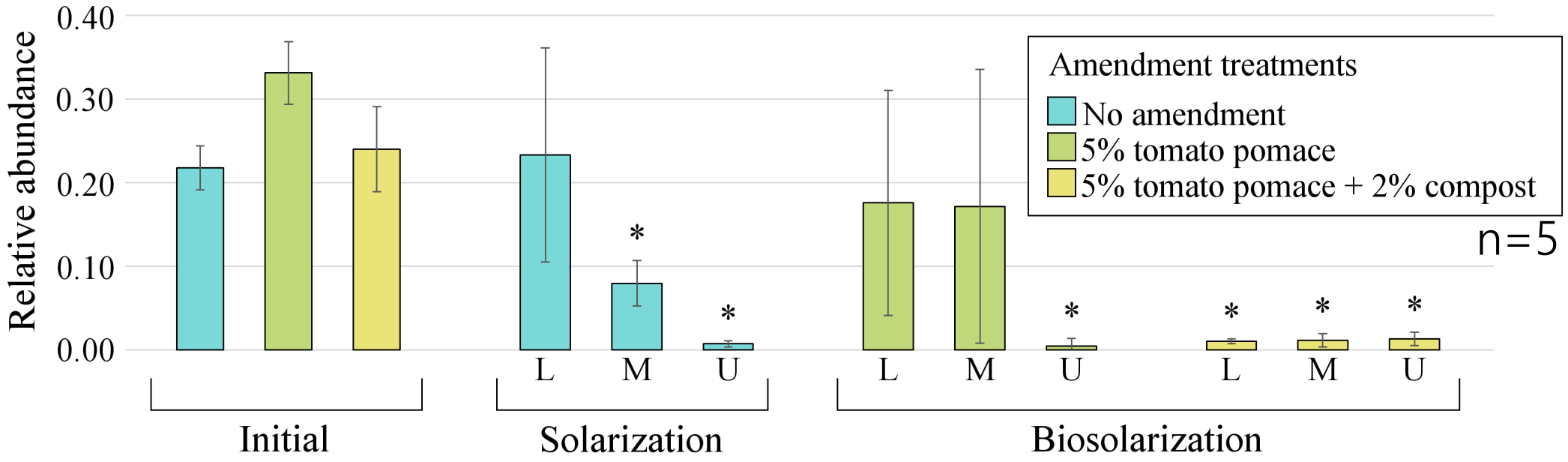
Fungal pathogen control



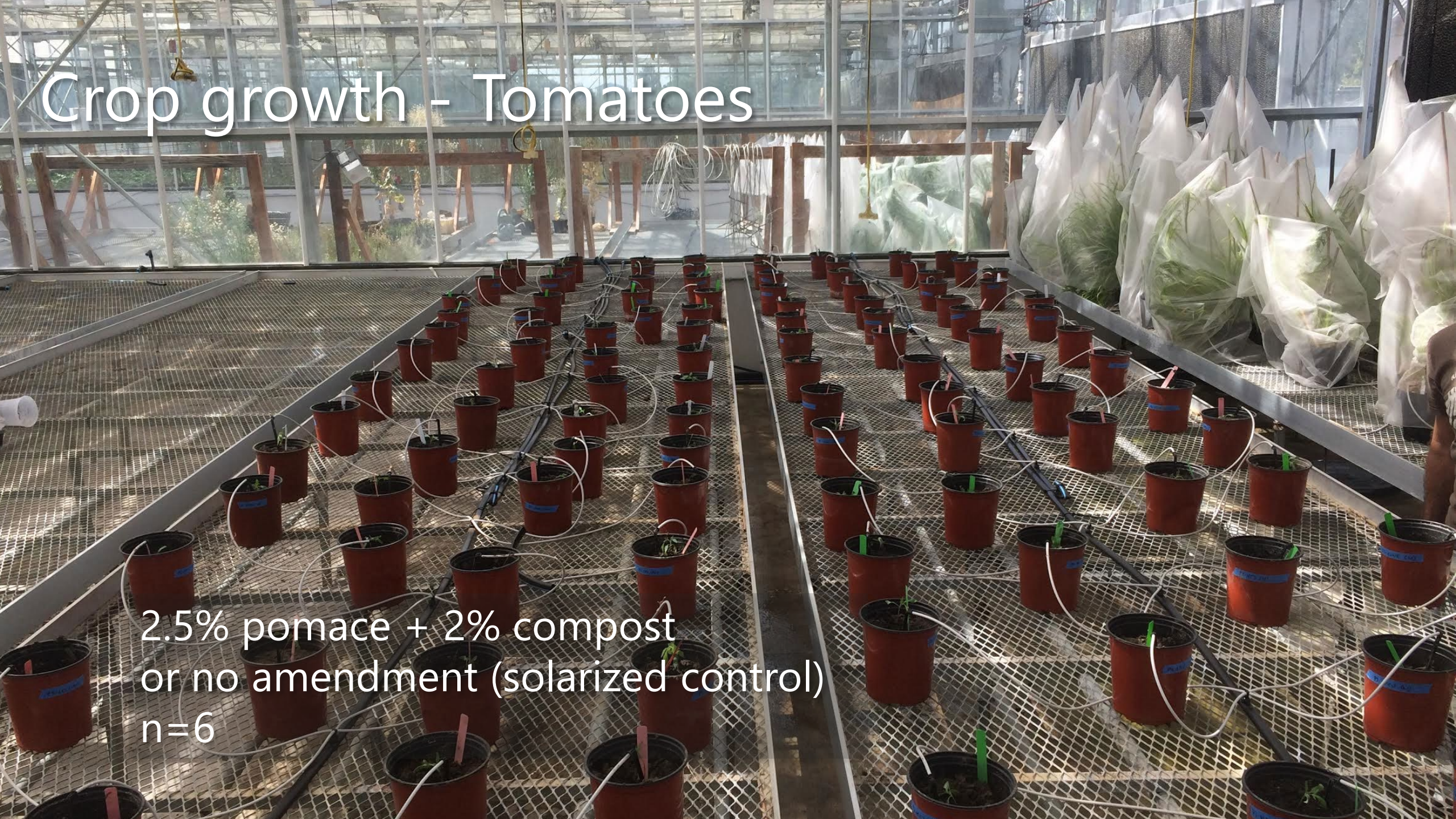
Gibberella – causes a variety of rot, wilt, and scab diseases

Fungal pathogen control

Giberella (causes rot and wilt in several crops)

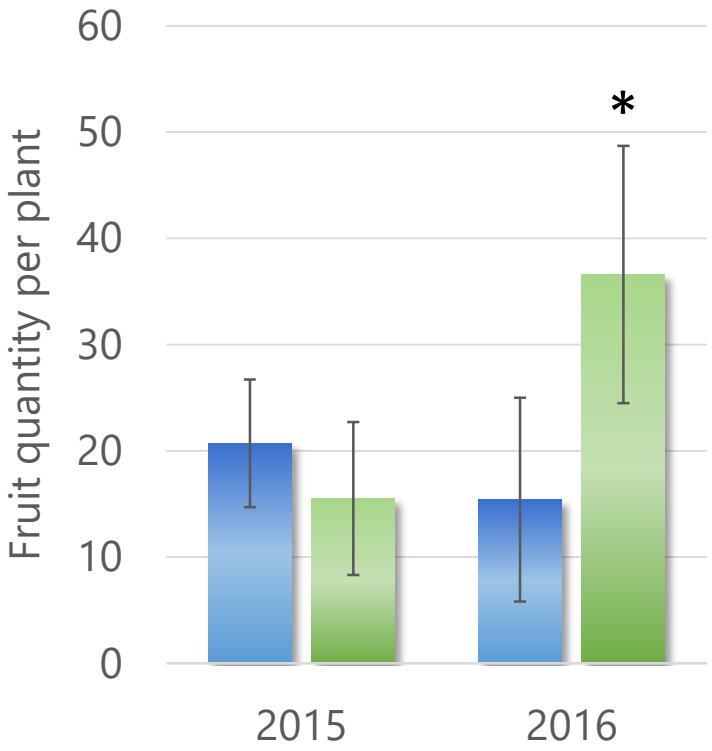


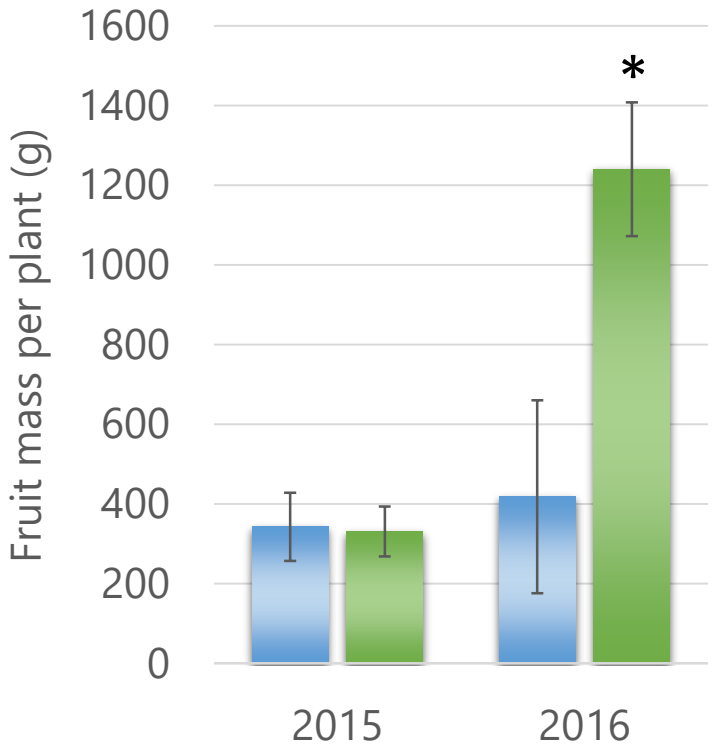
Crop growth - Tomatoes



2.5% pomace + 2% compost
or no amendment (solarized control)
n=6

Biosolarization can deliver yield benefits





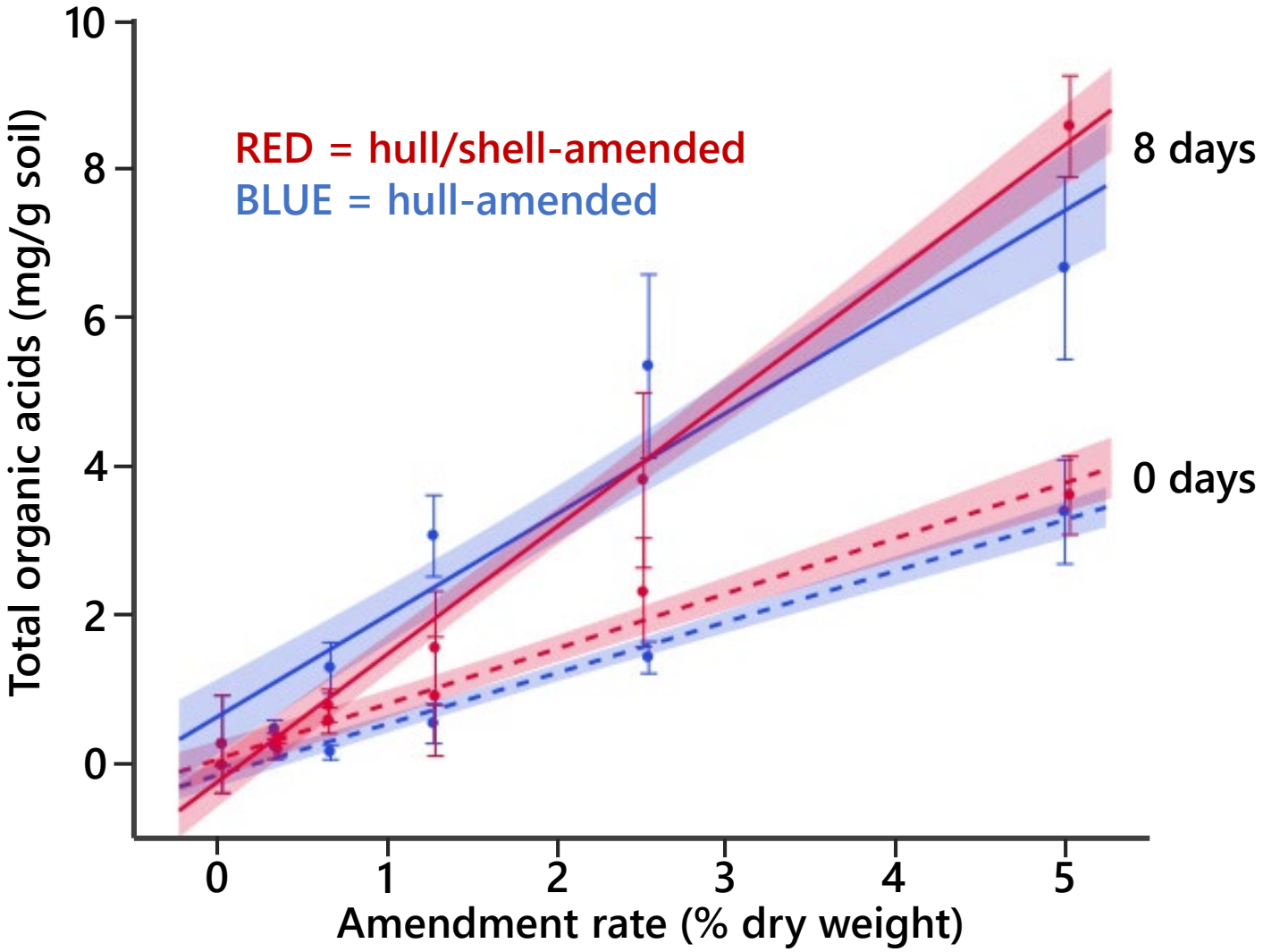
Solarized control: non-amended, solar heated

Biosolarized soil: amended and solar heated

* = significantly different from control ($P<0.05$)

Interfacing with the CA almond industry

Hull- and hull/shell mix-amendments lead to accumulation of organic acids in the soil



Endogenous organic acids on almond residues provide immediate acidification of the soil, which may improve pest inactivation kinetics.

Root lesion nematode (*Pratylenchus* spp.) inactivation

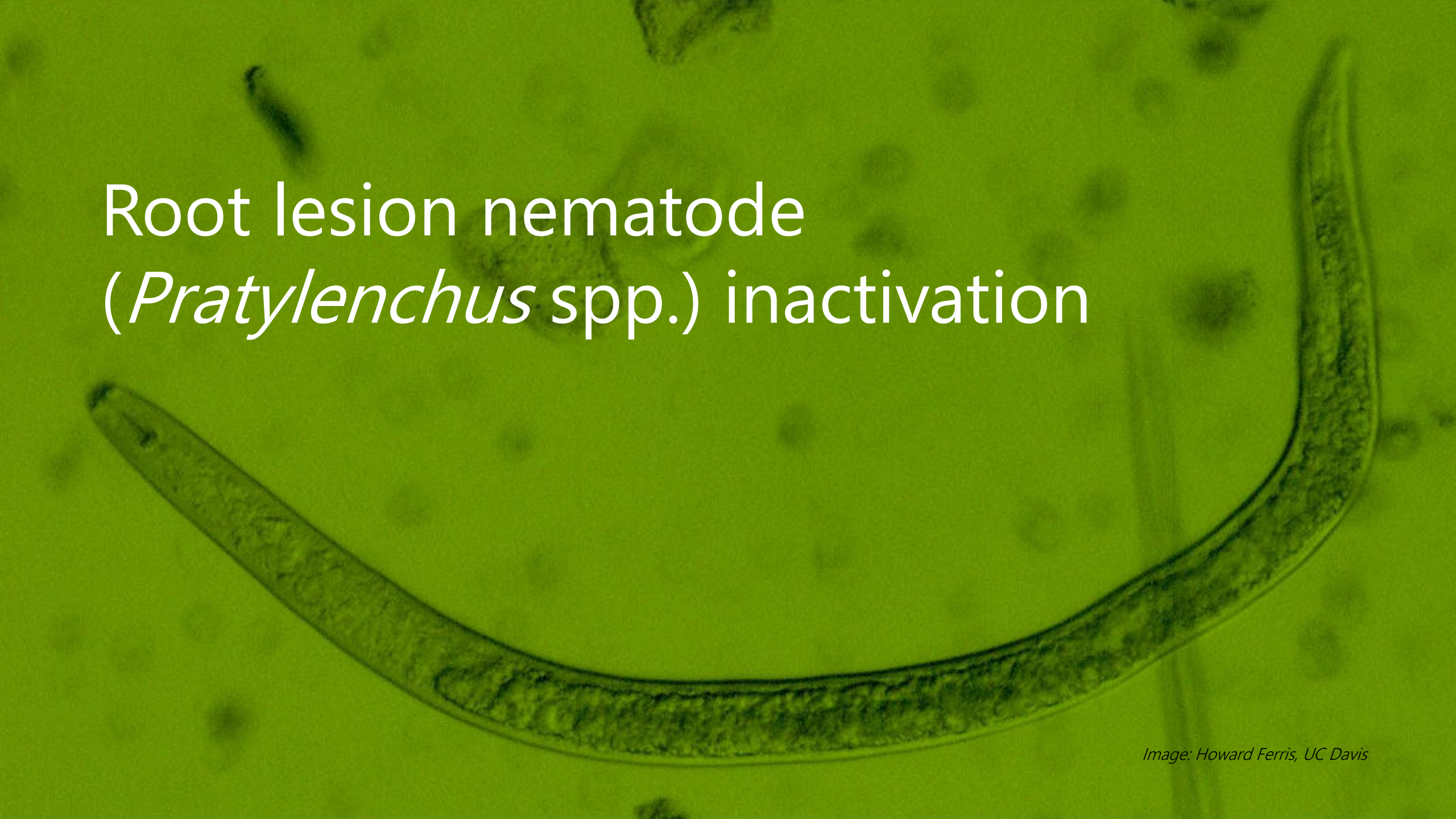
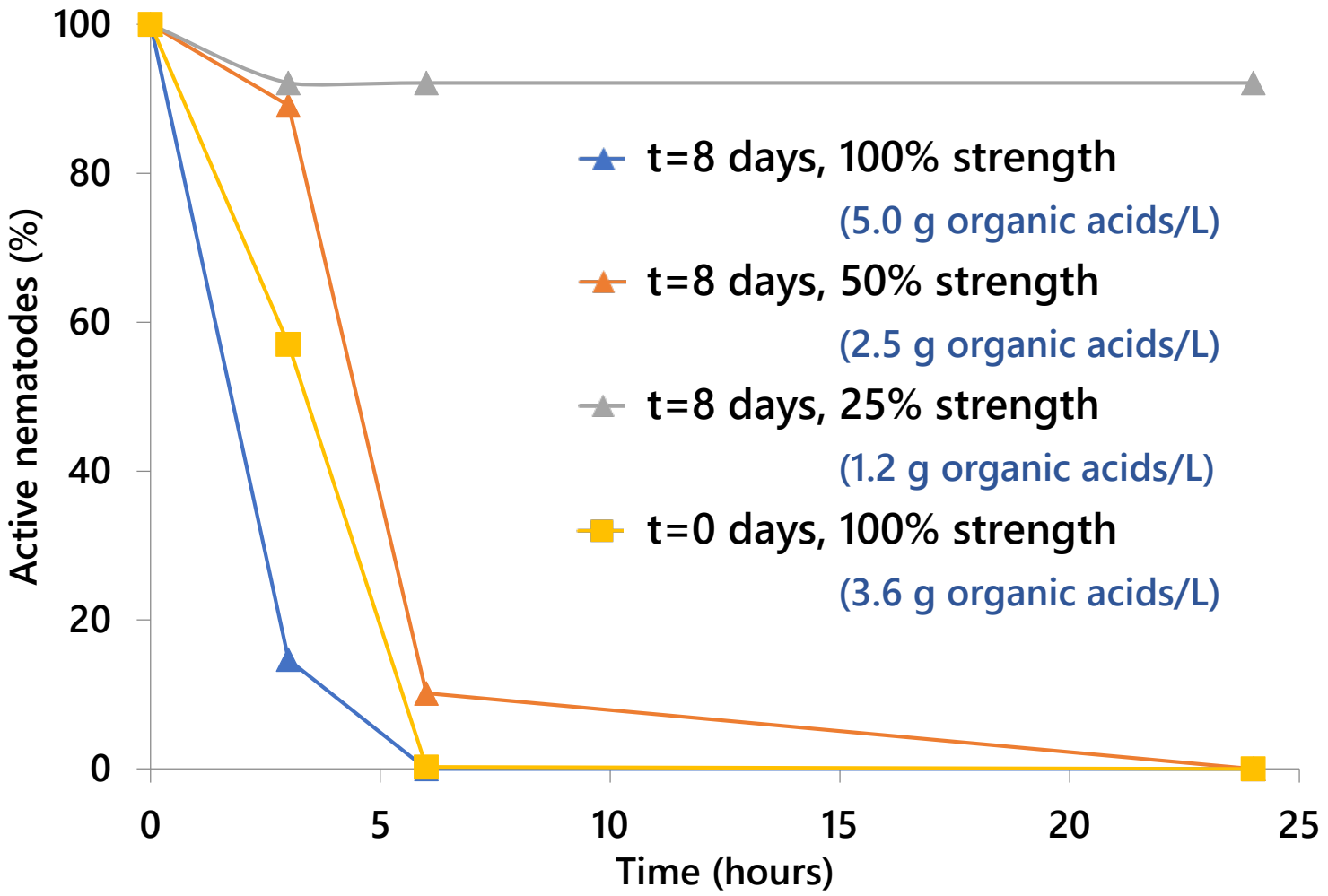


Image: Howard Ferris, UC Davis

Extracts from amended soils exhibit robust nematocidal activity



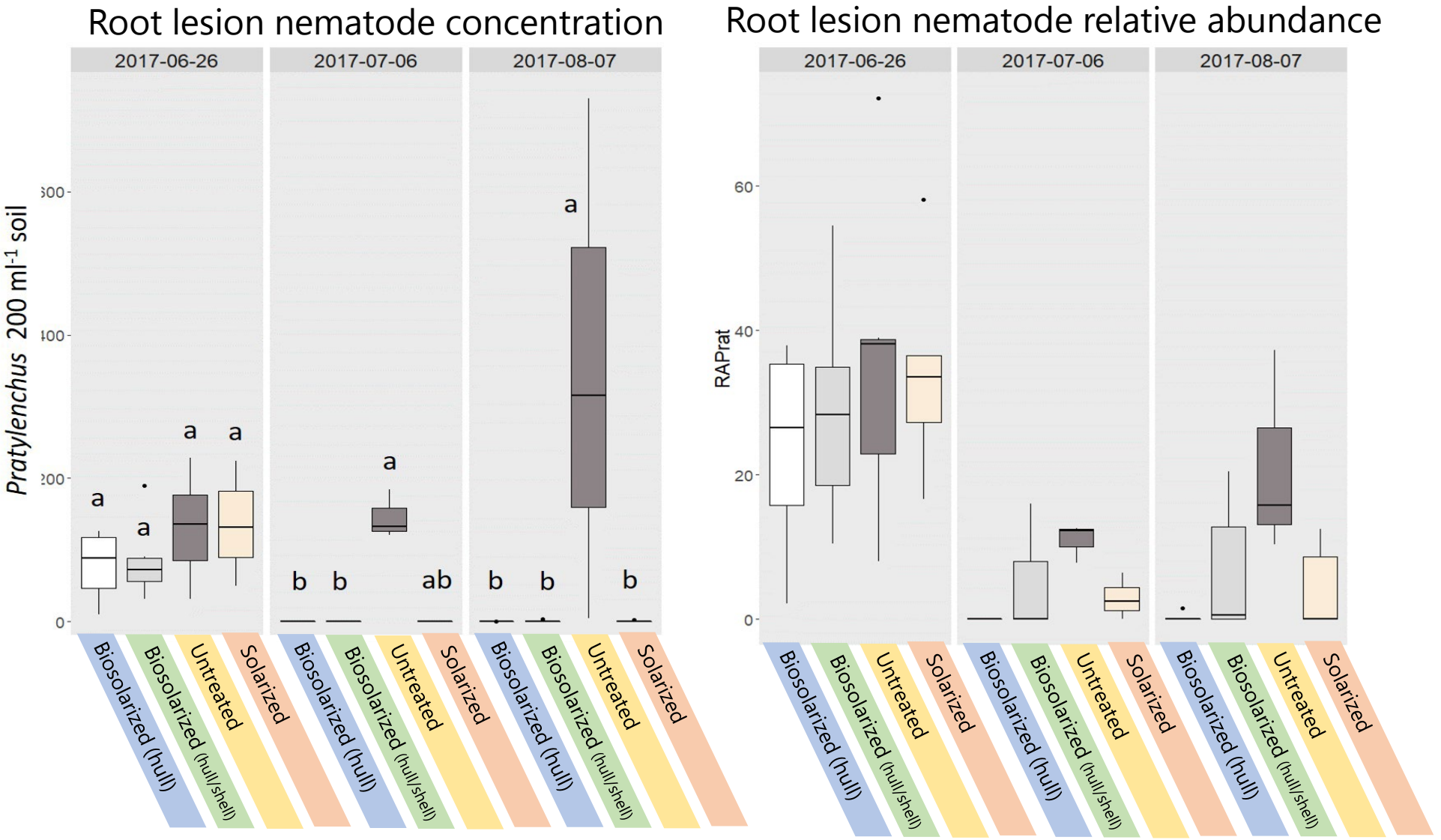
- Soil amended with nonpareil hulls (5% dw).
- Aqueous extracts taken immediately after amendment and after 8 days of anaerobic incubation.

Impact

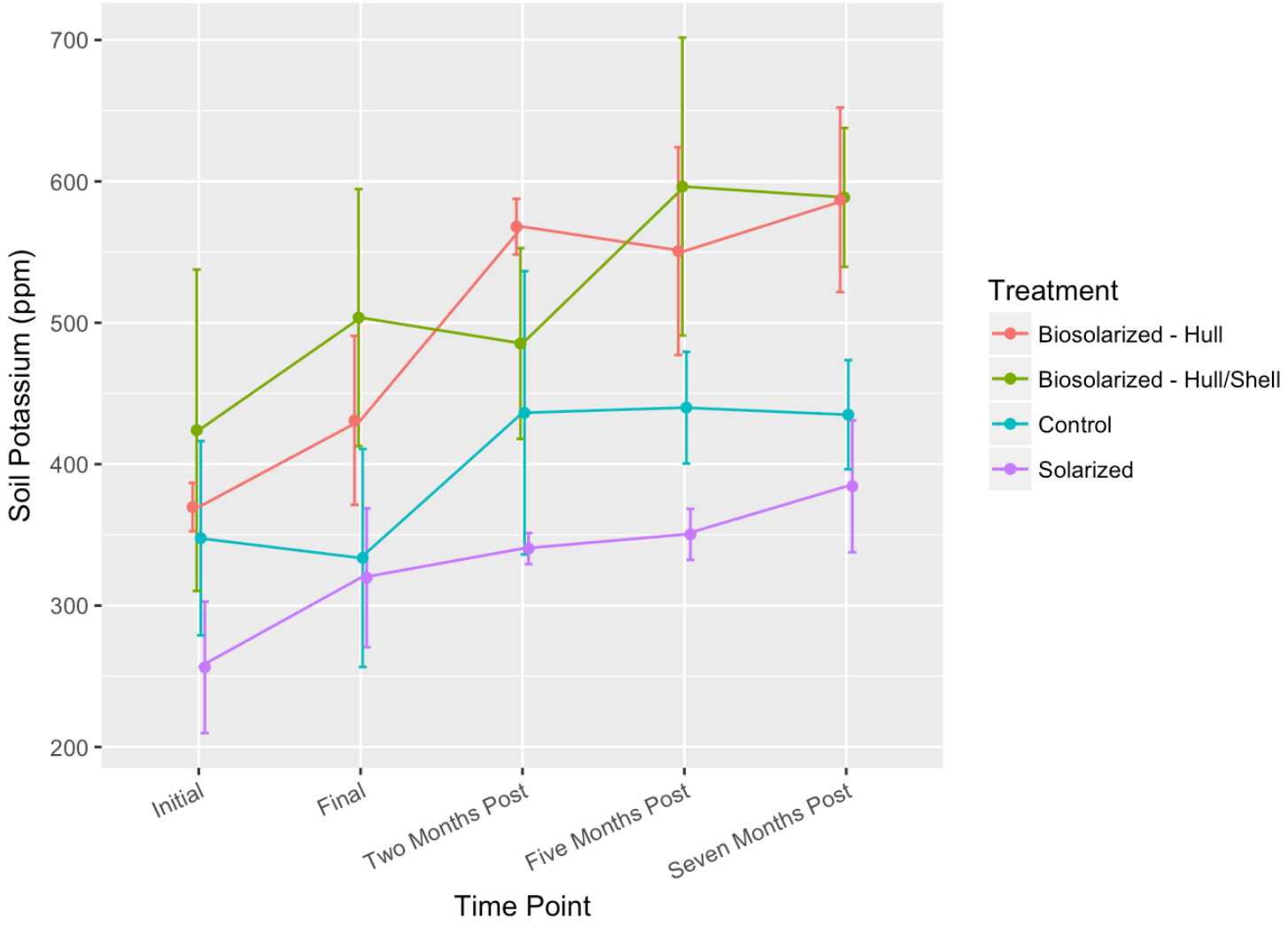
~10 acre field trial with
the Nicolaus Nut Co. in Chico, CA

Additional support from the Almond Board of California

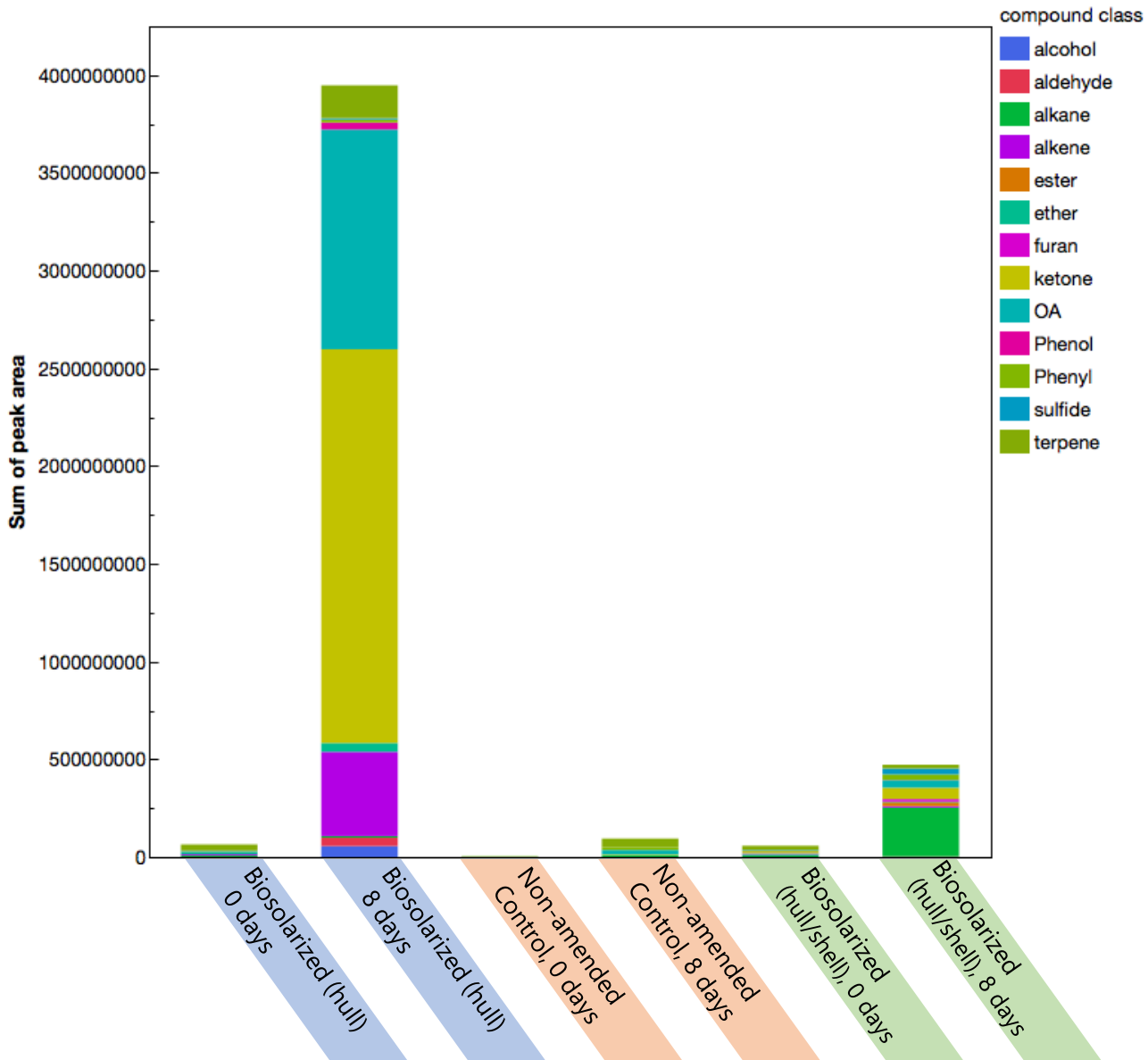
Root lesion nematodes were controlled in solarized and biosolarized soils



Biosolarization amendments can introduce plant nutrients to the soil



A complex array of volatile compounds are produced during biosolarization



A complex array of volatile compounds are produced during biosolarization

COMPOUND	PROPERTIES	PROMINENCE
Isoamyl Alcohol	•Anti-fungal •Starch fermentation by-product •unpleasant odor, irritant at 150 ppm	Small constituent of volatiles from hull amended samples ~ 1 %
2-Butanone	•Natural product: fruits, veggies, trees •PEL 200 ppm 8 hr	Medial constituent of volatiles from hull amended samples ~ 5-10
2-Pentanone	•plants and apple •PEL 200 ppm 8 hr	Medial constituent of volatiles from hull amended samples ~ 5-10
Diacetyl	•secondary or malolactic fermentation •"popcorn workers lung", PEL 8 hr 0.01 ppm	Large constituent of volatiles from hull amended samples ~ 10 %
Acetoin	•product of microbial fermentation •Antimicrobial •Plant - growth promoting •Oxidizes to **diacetyl** on exposure to air.	Very large constituent of volatiles from hull amended samples ~ 20 %
phenylethyl alcohol	•found in almond •Saccharomyces cerevisiae, plant, aspergillus metabolite •antimicrobial, antiseptic •plant growth retardant	Small constituent of volatiles from hull amended samples ~ 1 %

Ongoing work

- Almond yield effects
- Effects on additional crops
- Exposure risk reduction
- Grower outreach

Acknowledgements

Tomato pomace project:

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jbei Joint BioEnergy Institute

JGI JOINT GENOME INSTITUTE UNITED STATES DEPARTMENT OF ENERGY

Acknowledgements – Almond residue project

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