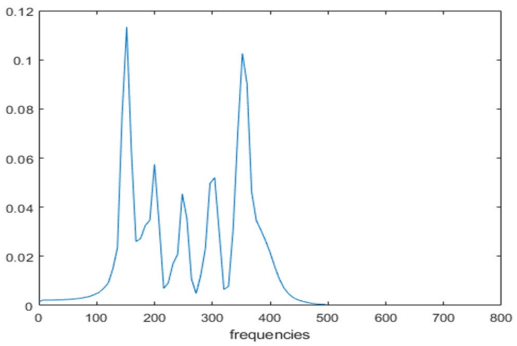
The use of Vibrations and Plant derived products to replace mineral oils in organic farming

Rachele Nieri, Vincenzo Verrastro, Andrea Nesler, Valeria Fattoruso, Alice Berardo, Nicola Pugno

Valerio Mazzoni



Plant Protection Unit
Research and Innovation Centre
Fondazione Edmund Mach
San Michele all'Adige, Italy

Biotremology & SemioPhysicals

The discipline that studies the **Vibrational Communication** in Animals

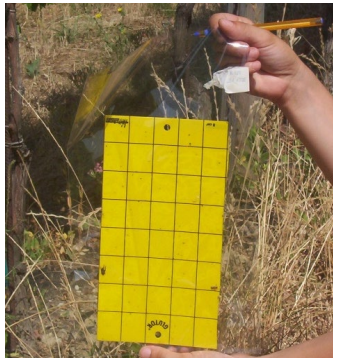
Physical signals that can trigger a behavioral response in receiving organisms

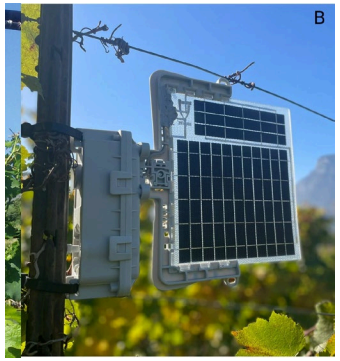
Nieri et al., 2022, Entomologia Generalis

- Lights and Colors
- Sounds
- Vibrations

Sounds

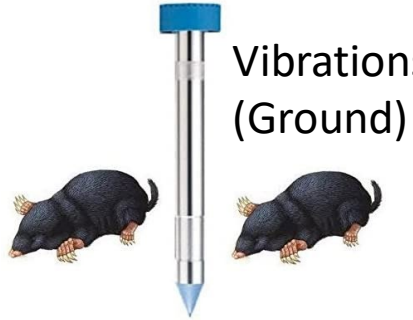
Colours





Vibrations
(Organic substrates)

Lights



Vibrations
(Ground)

Ultrasounds

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Research Objectives (Relacs Project)

STEP 1: Description of the Mating Behavior and Vibrational Signals of the Greenhouse Whitefly (GW), *Trialeurodes vaporariorum*

STEP 2: Development of a vibrational disruptive device to control the GW populations

STEP 3: Trials in the Greenhouse on Tomato plants infested with GW

RELACS
IMPROVING INPUTS FOR ORGANIC FARMING

RELACS has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement No 773431. The information contained in this communication only reflects the author's view.

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STEP 1

Objectives

- Description of vibrational signals and mating behaviour of the greenhouse whitefly
- Identification of frequency patterns to create synthetic signals for behavioral interference

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STEP 1

Recording set-up: Lab of Biotremology

Sound Insulated chamber

Soft-box

Laser Doppler vibrometer

Macro Lens

0.7 - 1 mm

Whiteflies
(Trialeurodes vaporariorum)

Anti-vibration table

Nome scientifico:

Trialeurodes vaporariorum Westwood

Nome comune: **Mosca bianca delle serre**

Ordine: **Homoptera**

Famiglia: **Alurodidae**

Nell'agroecosistema: **Parassita**

Piante ospiti: **Pomodoro, Tabacco, varie colture orticole e floricole ornamentali.**

Distribuzione: **Mondiale**

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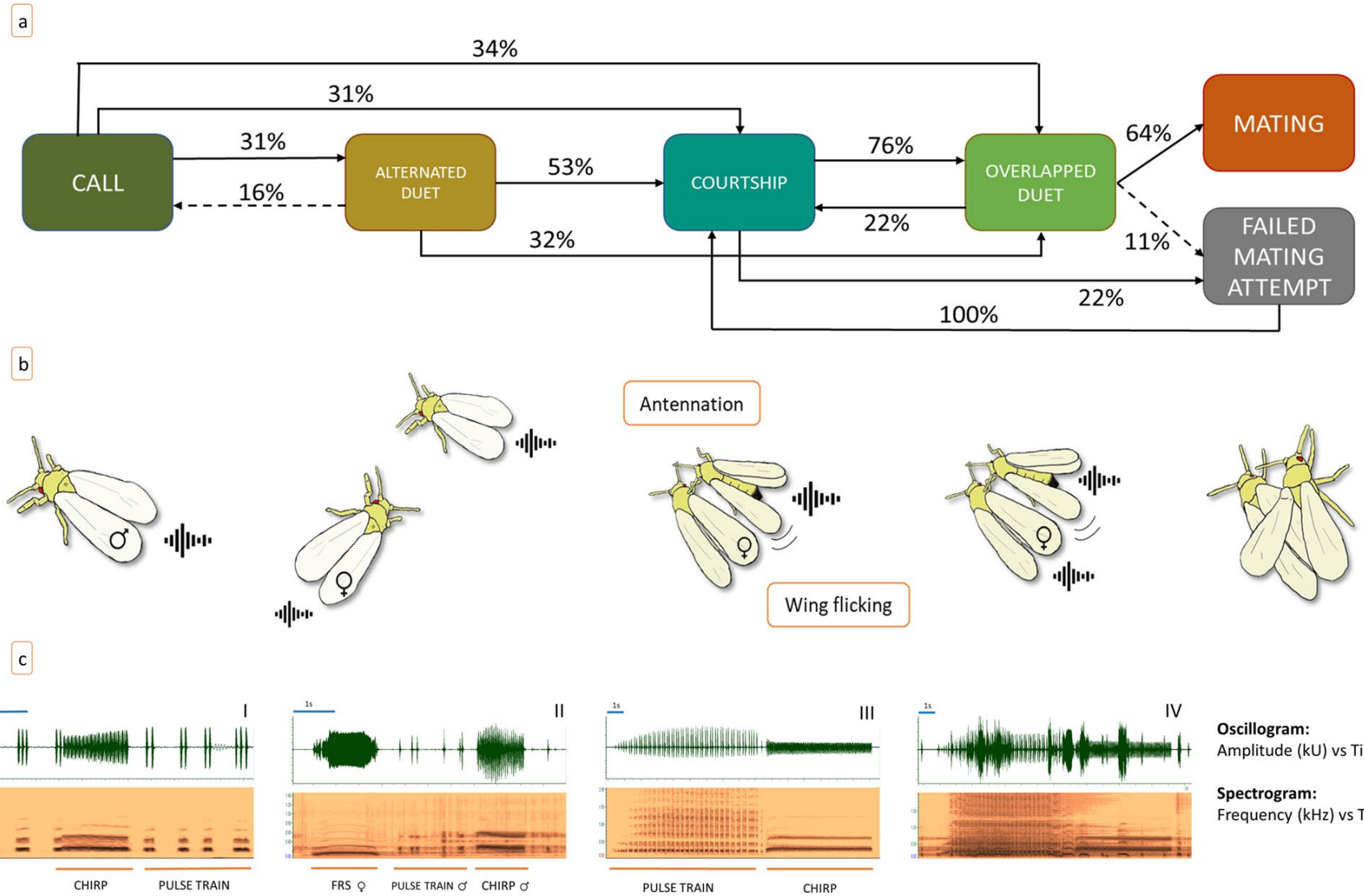
STEP 1

MATING BEHAVIOR OF TRIALEURODES VAPORARIORUM



Fattoruso et al., 2021, Scientific Reports

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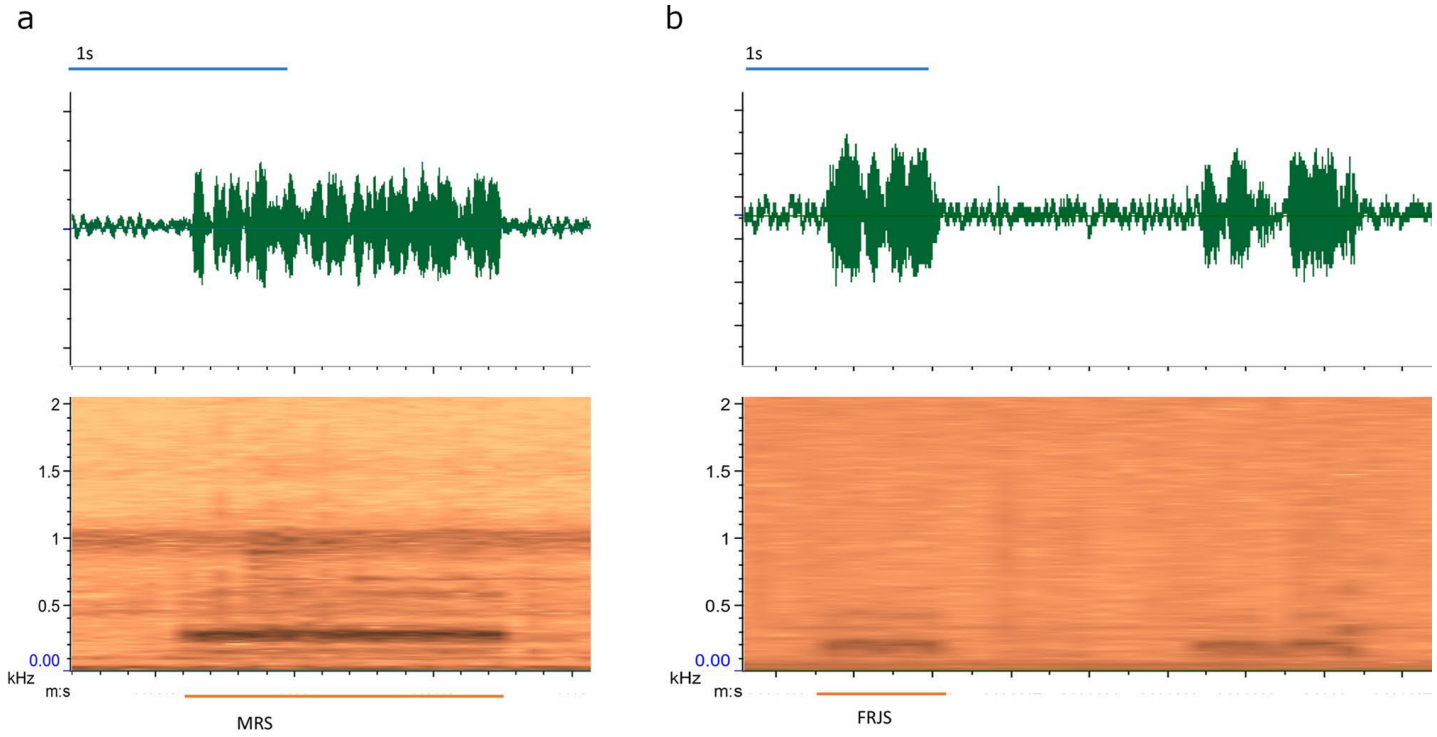
STEP 1

Male Rivalry and Female Rejection Signals

Male Rivalry Signal

Female Rejection Signal



In these circumstances, mating attempts always failed

STEP 1

Results

- *Trialeurodes vaporariorum* use **vibrational signals** during pair formation
- The establishment of a **vibrational duet** is required to accomplish mating
- The mating behavior consists of distinct steps, each mediated by a peculiar **male/female vibrational interaction**
- **GW male rivalry signal/female rejection signals** appears to have an effect in interrupting and delaying mating

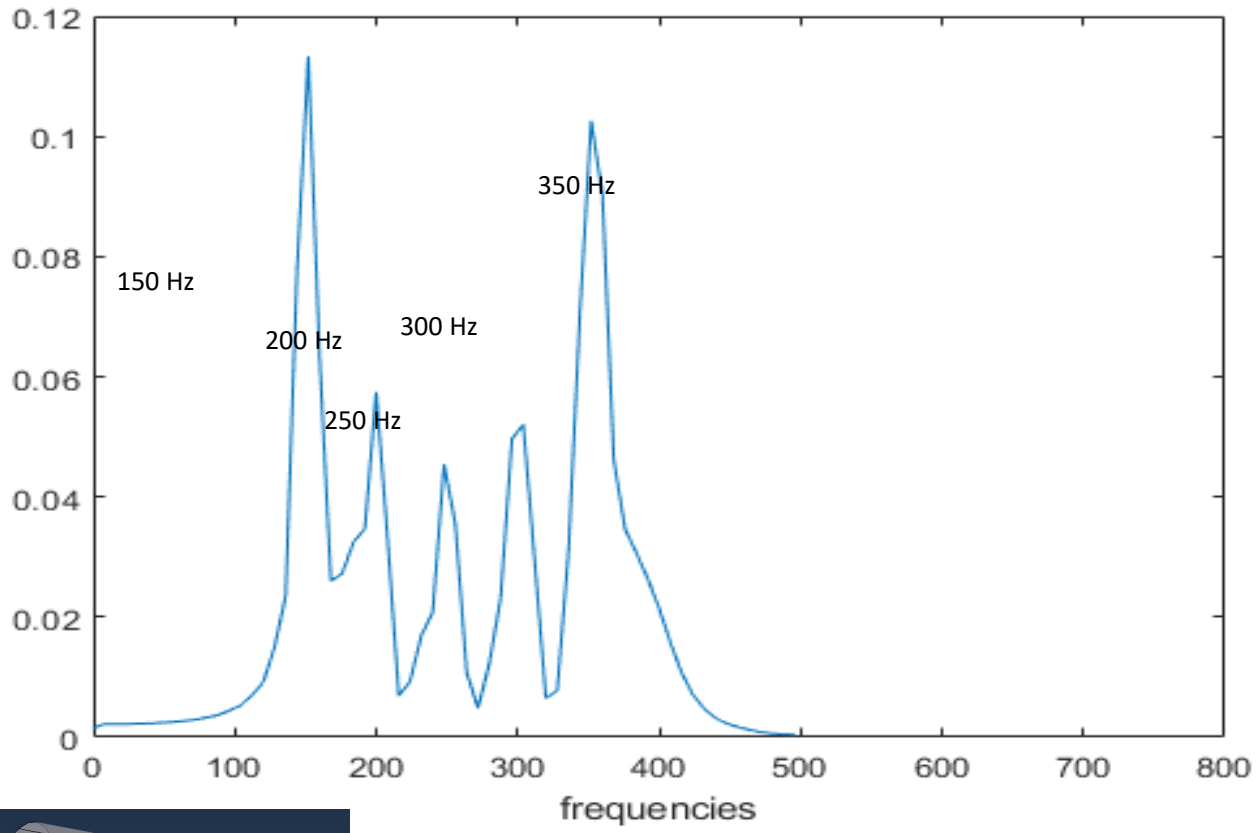
STEP 2

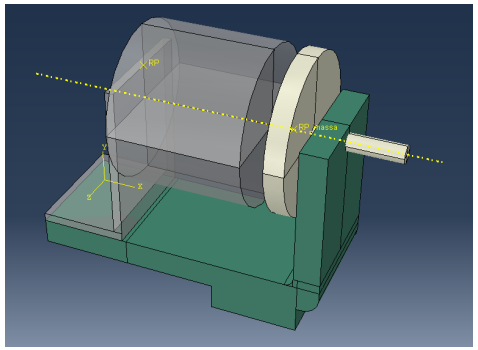
Objectives

- Development of a **synthetic Vibrational Disruptive Noise (VDN)**
- Development of a **device (VibroPlate)** for the transmission in playback of the VDN to tomato plant in the greenhouse

Playback of the Disturbance Vibration Noise (VDN)

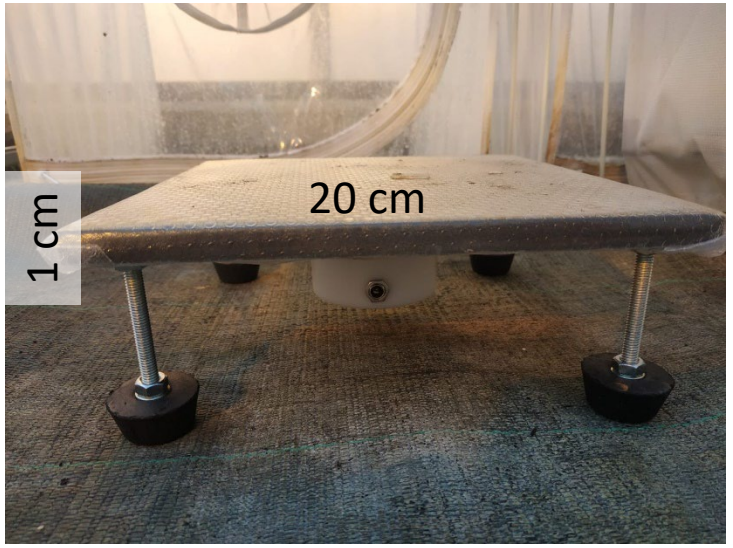
STEP 2





VDN Audio

Vibro-Plate



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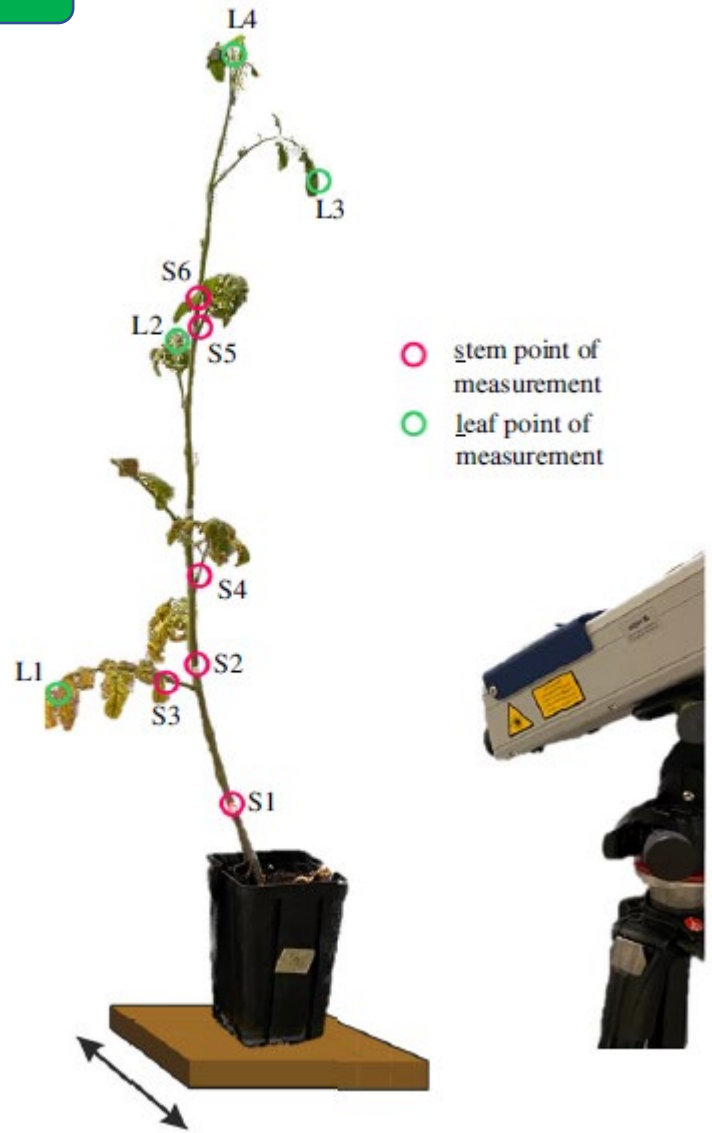
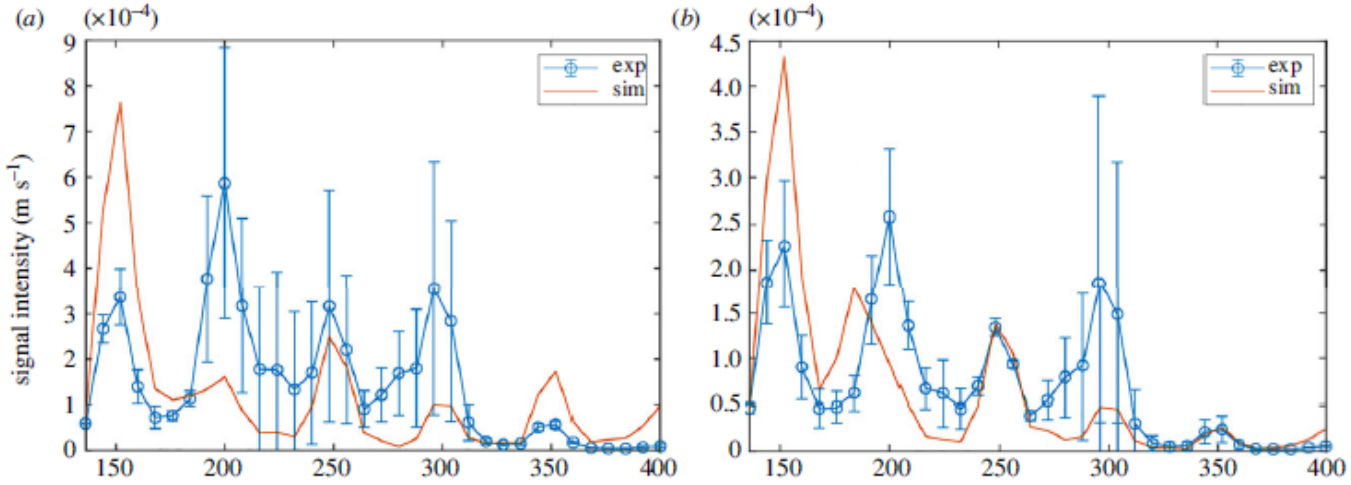
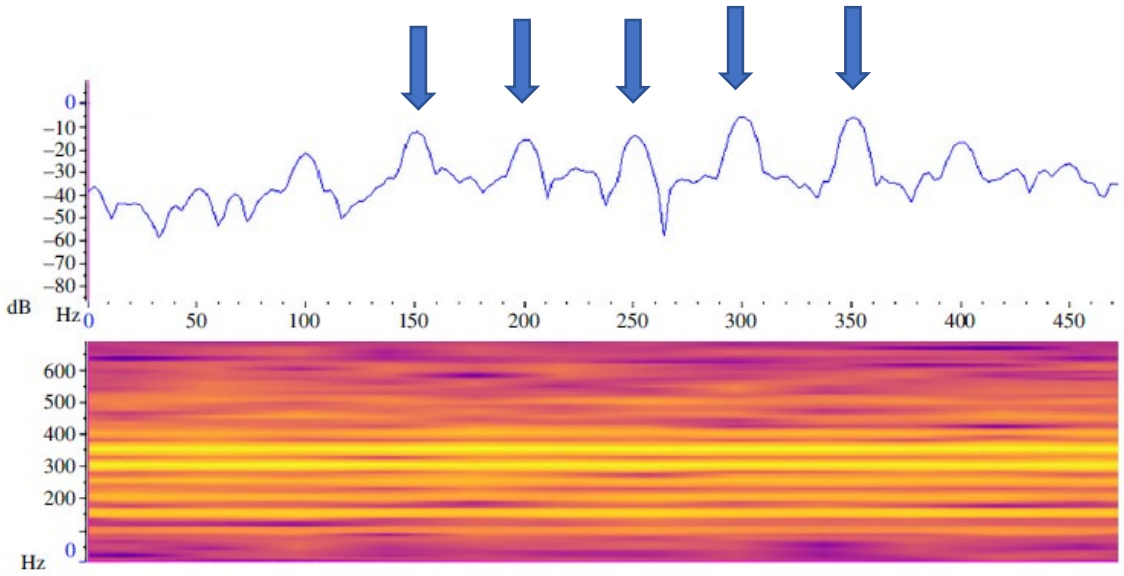
VDN transmission to tomato plants

STEP 2



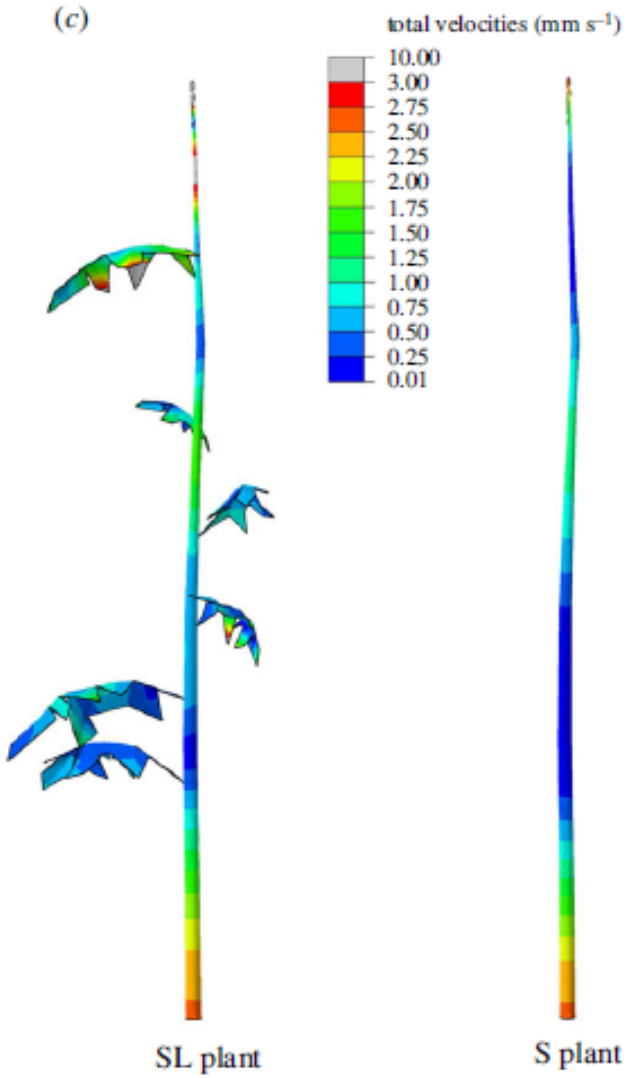


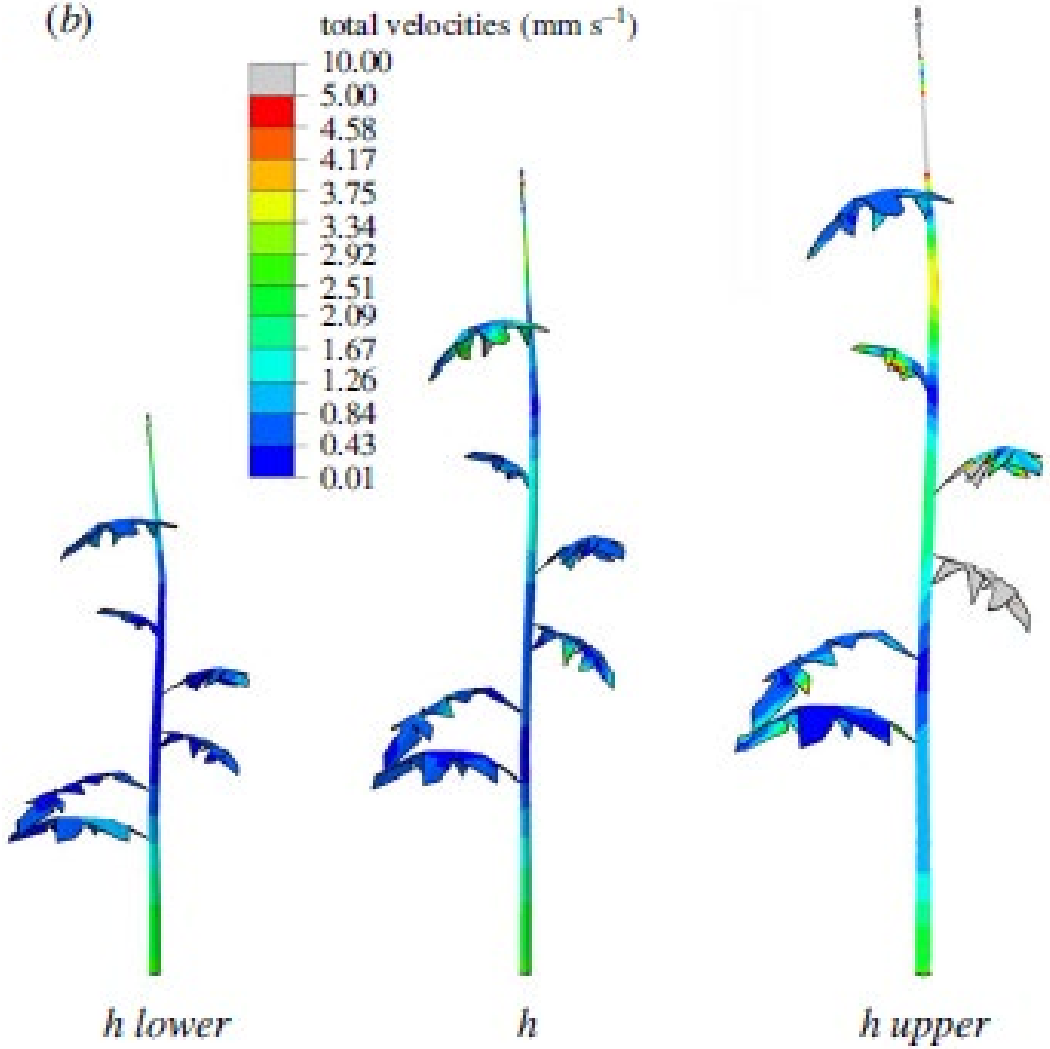


Berardo et al., 2023, Interface

Numeric Models and VDN transmission

STEP 2





STEP 2

Exp.1 Groups of potted plants

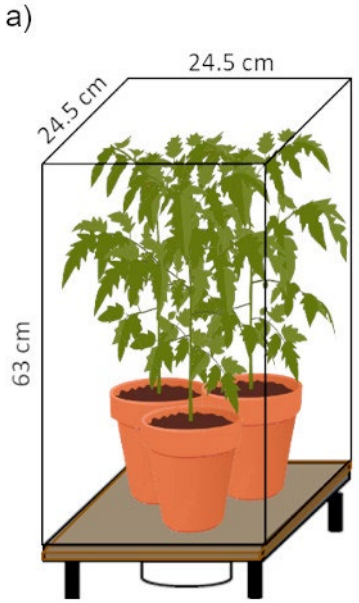
Experiment 1: Control of *T. vaporariorum* on Tomato potted plants

STEP 2

N =4

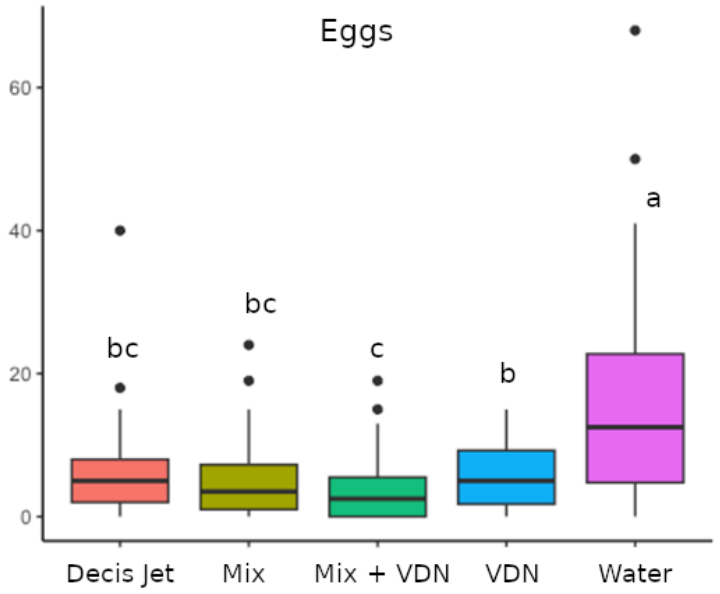
500 adults/24h

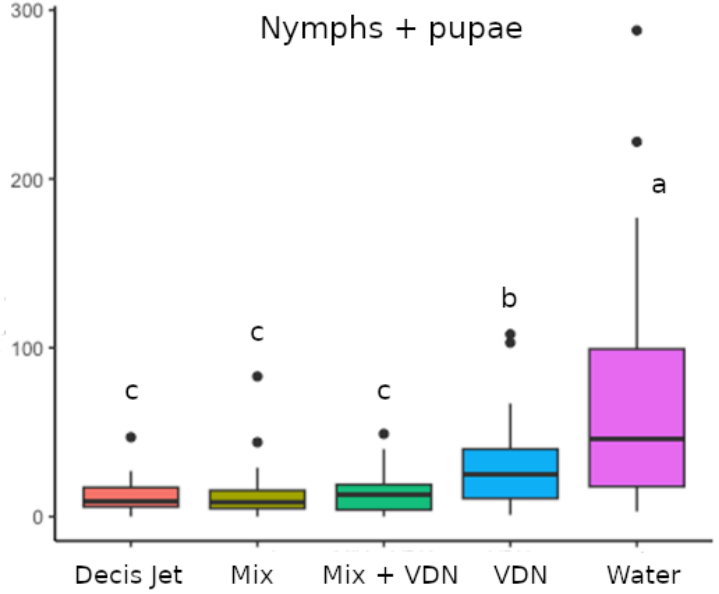
Treatment when nymphs appear

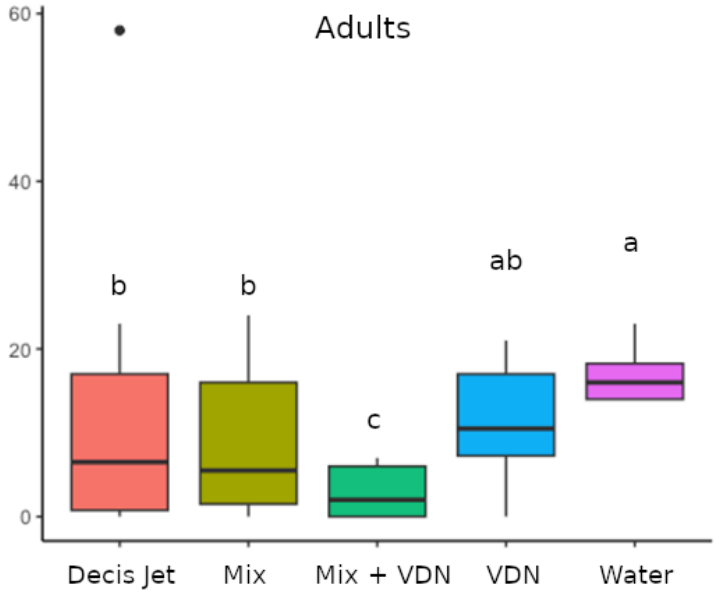


5 Treatments

- Deltamethrin (Positive Control) (1 Treat)
- Only Disturbance Vibrations (VDN)
- Green Pesiticides (MIX) (1 Treat)
- VDN + Green Pesticides (VDN+MIX)
- Water (Negative Control)







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STEP 2

Results

- The Plant Derived Products (MIX) showed interesting results in containing the GW population;
- the **VDN** appears to have an effect **in reducing the population growth**, likely interfering with the mating and the number of eggs laid by females;
- The **combination of MIX and VDN seems to be very promising** (possible synergic effect).

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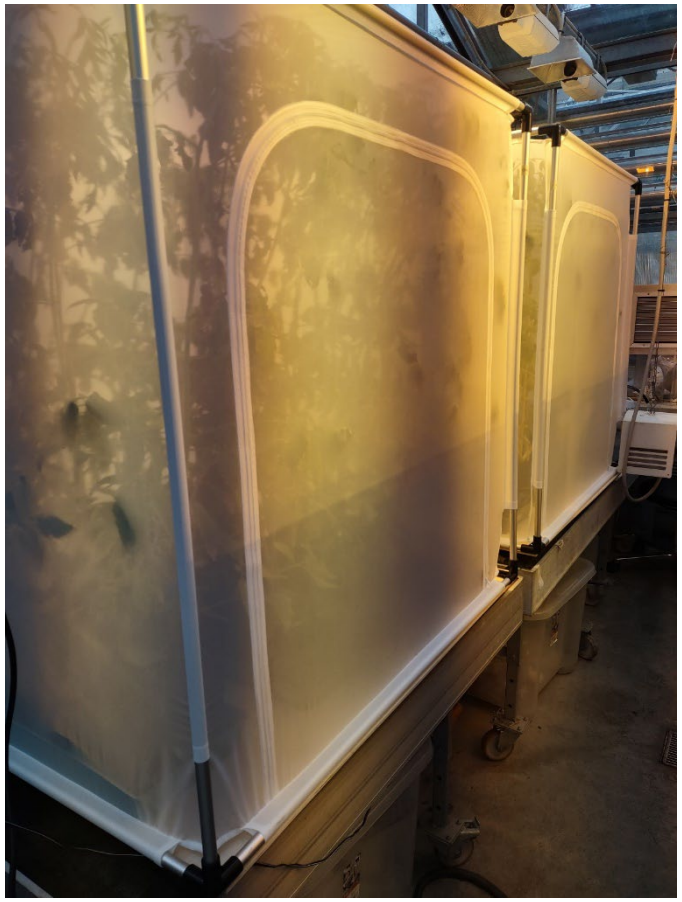
STEP 3

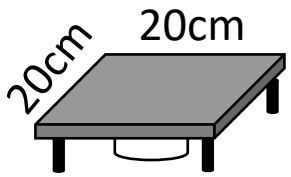
Objectives

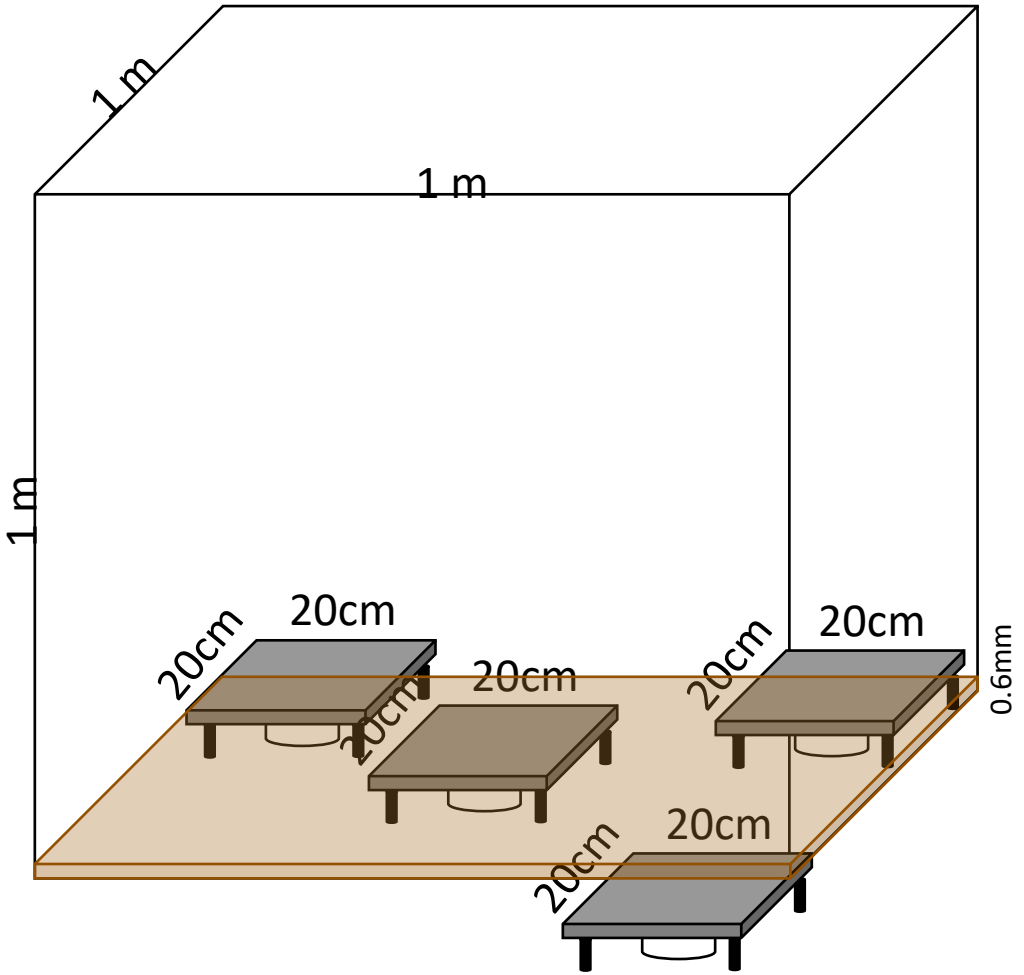
- Testing the Vibroplate in commercial-like Greenhouse to assess the efficacy of the combination of MIX and VDN against GW

STEP 3

Trials in commercial-like greenhouse

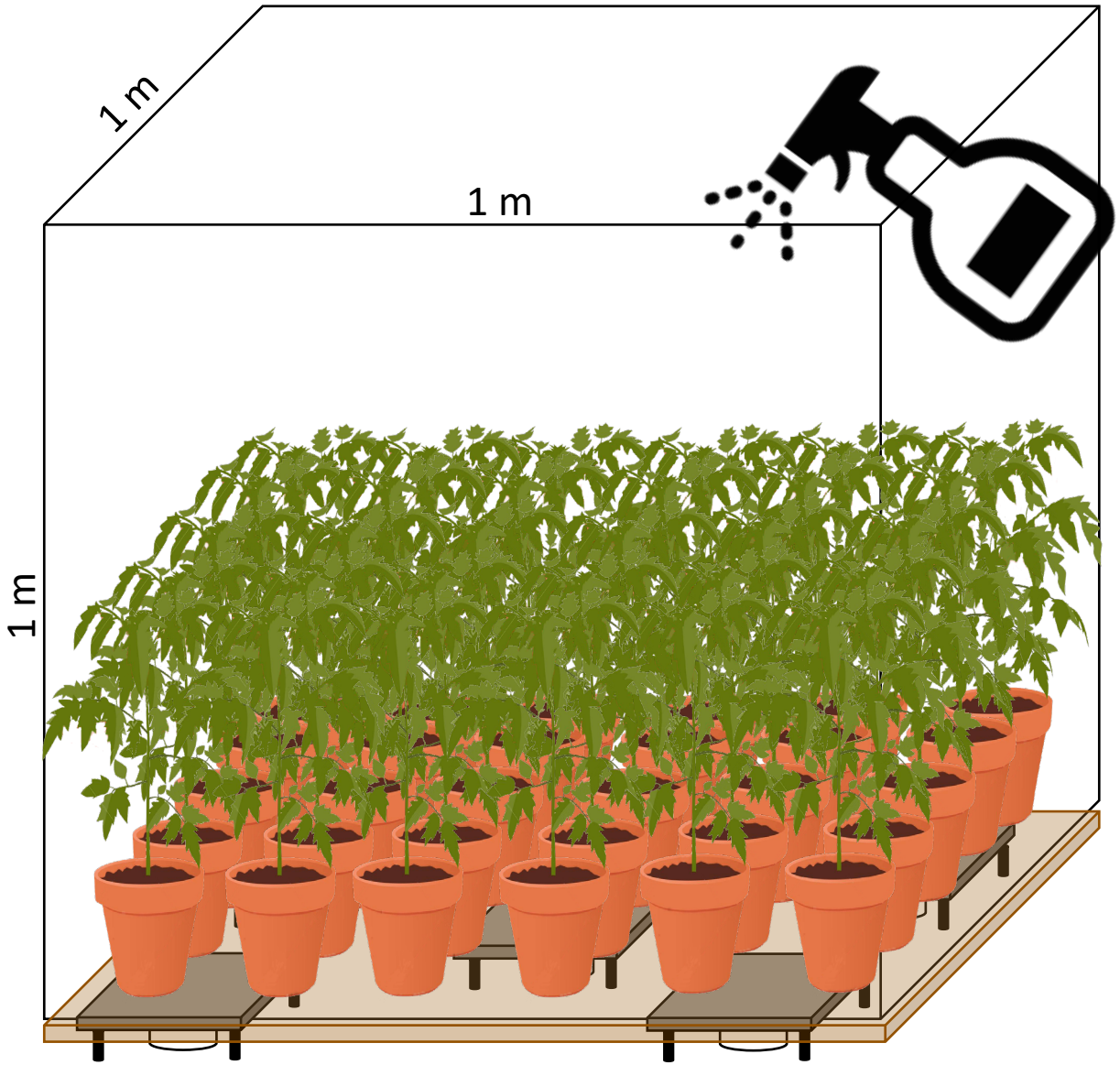






STEP 3

- A cage of 1m^3 was placed on top of a wood panel (thickness 0.6mm) laied above 5 vibrating plates.
- Inside the cage, 30 plants of potted tomatoes were placed evenly spaced.
- The intensity of the vibration at the **frequency peak (200 Hz)** was measured with a laser Doppler vibrometer on the leaves of 5 plants in different positions inside the cage (**min. 70 µm/s – max. 500 µm/s**) (minimum threshold 10 µm/s).
- Before the inoculation (50 adults of *Trialeurodes vaporariorum*), plants in the treated cages (=Combo) were sprayed **with a combination of two plant derived products.** A second treatment repeated after 1 week.



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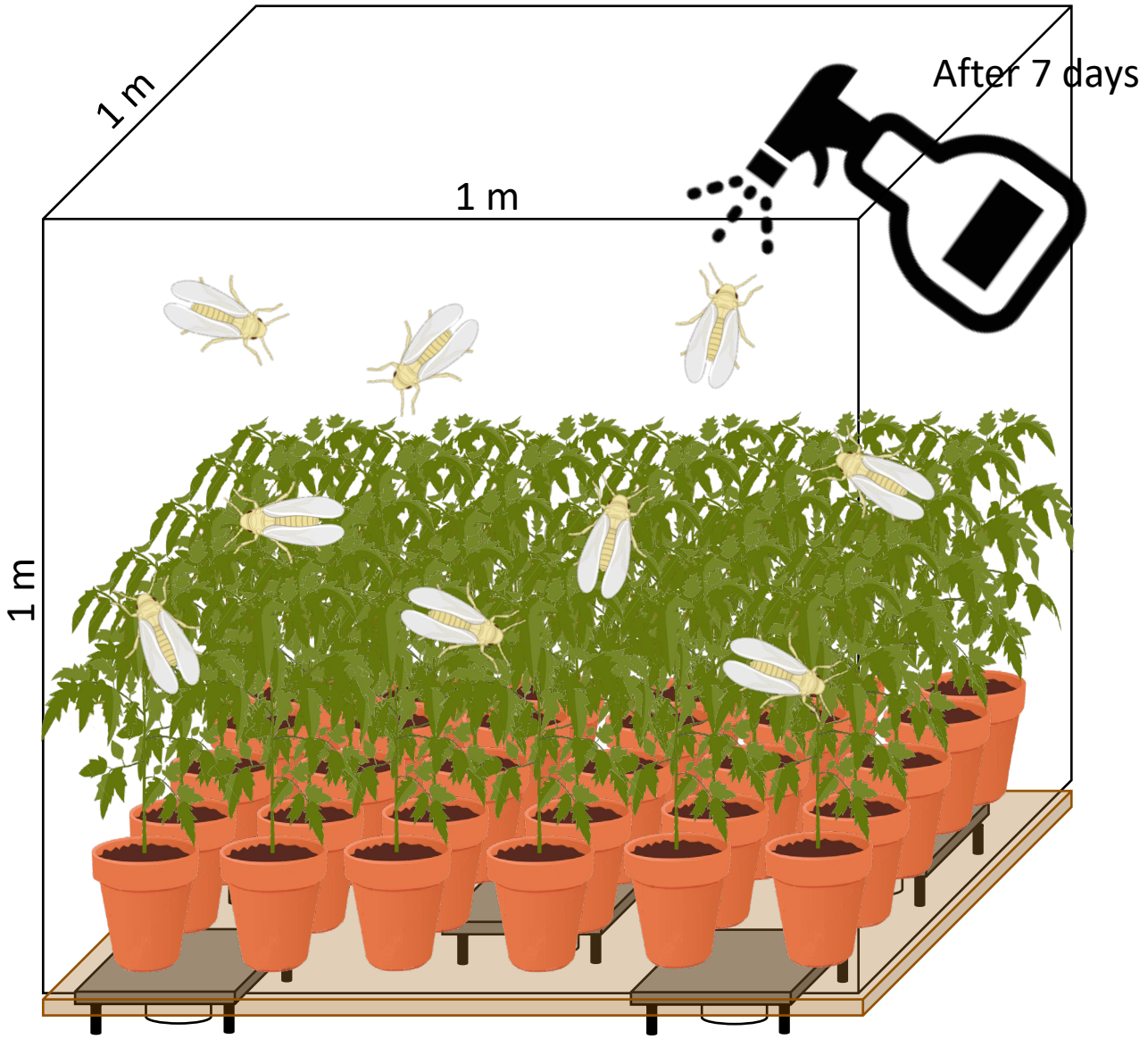
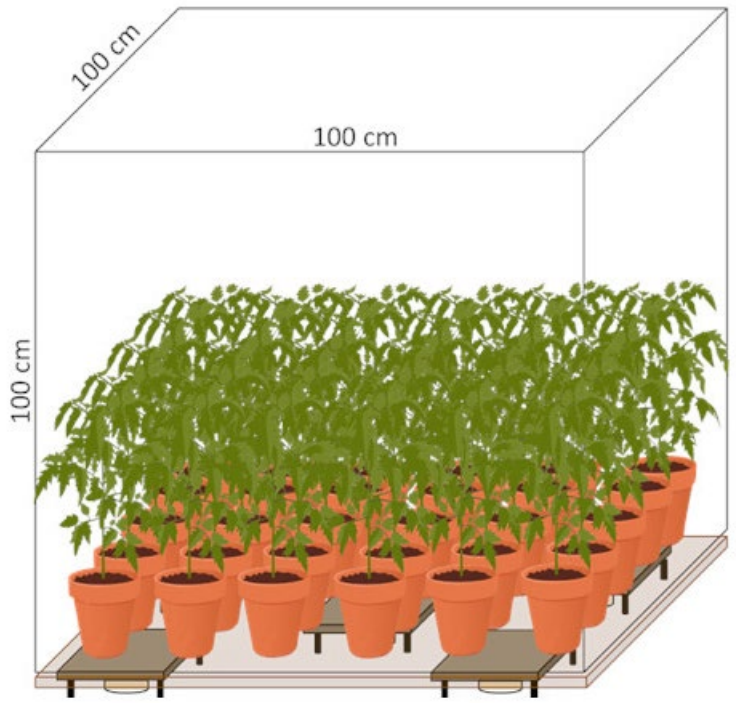
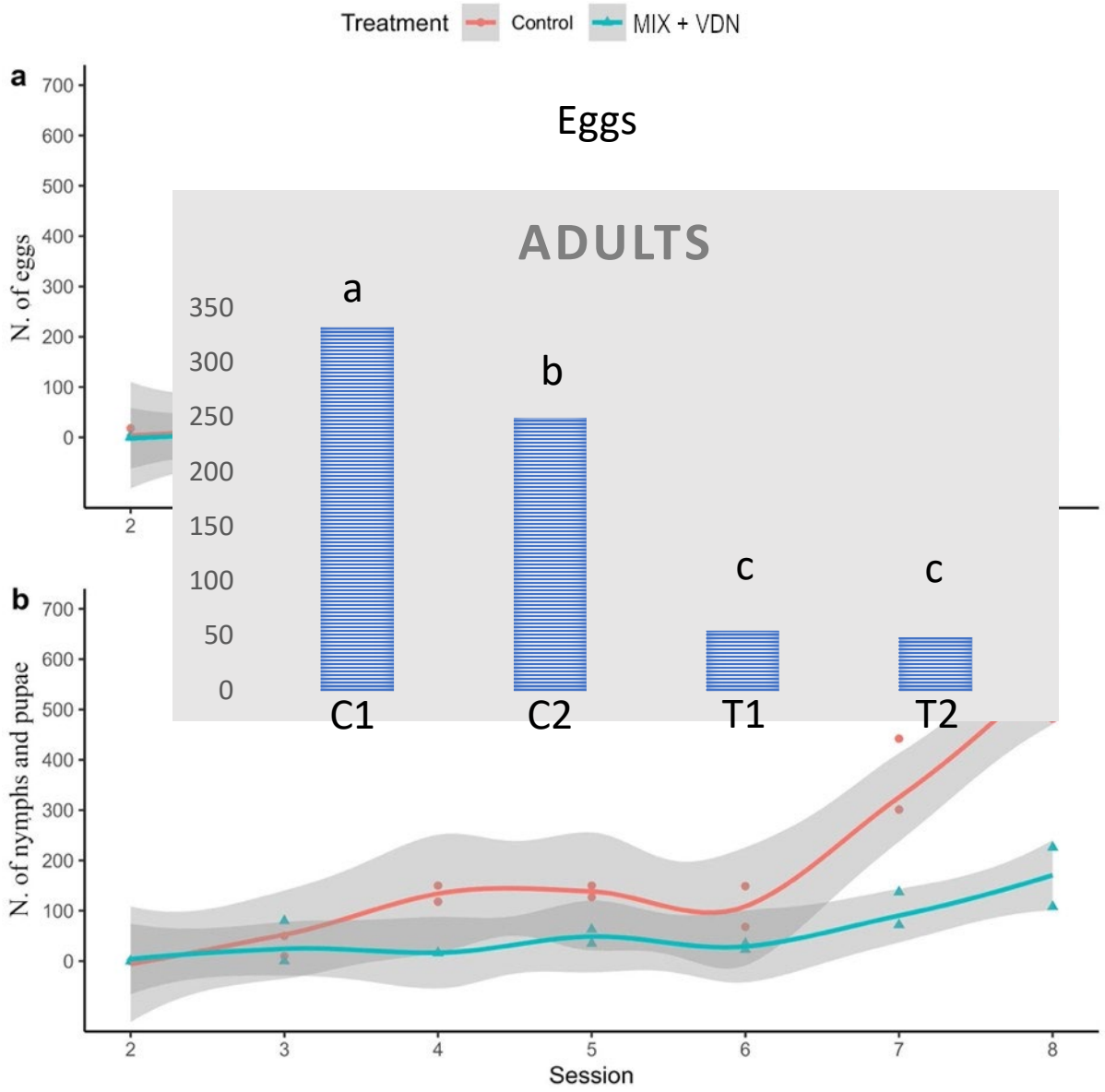


Experiment 2: Results

b)





Summary

STEP 1

- The mating behavior and associated vibrationals signals of *T. vaporariorum* were described.
- A **playback of a synthetic disturbance vibrational signal (DVS)**, designed to mask the GW mating signals was created and tested.

STEP 2

- A device, «**Vibroplate**», to transmit the signal to potted plants in greenhouse (with the option of transmitting it also through wires) has been made and used for trials.
- The combined use of plant derived products and playback of DVS gave significant results in preliminary tests at small scale (few plants of tomato and zucchini plants).

STEP 3

- Experiments at greenhouse-like scale (benche with 30 plants each) gave significant reductions of GW populations on tomato potted plants.
- **Our results showed that Disruptive Vibrational Signals can control *T. vaporariorum* populations when combined with the mixture of plant derived products**.

AKCNOWLEDGEMENTS

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CIHEAM
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