

From waste to protection: evaluating the efficacy of *Tenebrio molitor* insect frass in the of tomato soil-borne pathogens suppression



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INTRODUCTION & MAIN GOAL

The increasing restrictions on chemical pesticides and fertilizers are driving the search for sustainable agricultural inputs. **Insect-derived by-products** have emerged as promising alternatives due to their potential biostimulant and bioprotective properties (Zunzunegui et al., 2025). Frass from *Tenebrio molitor* represents a valuable resource within circular economy strategies (Zunzunegui et al., 2024).

While its fertilizing effects have been widely explored, its role in plant disease suppression remains insufficiently understood. The aim of this study was to evaluate the antifungal activity of *T. molitor* frass against major tomato soil-borne pathogens and to assess its impact on plant performance under pathogen pressure.

METHOD

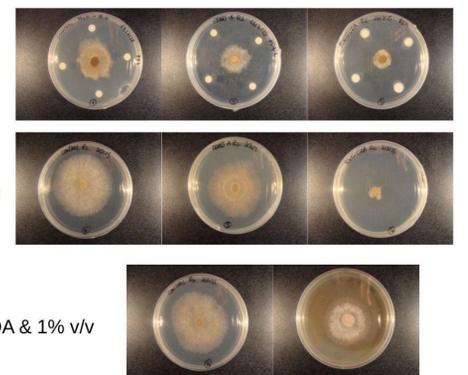
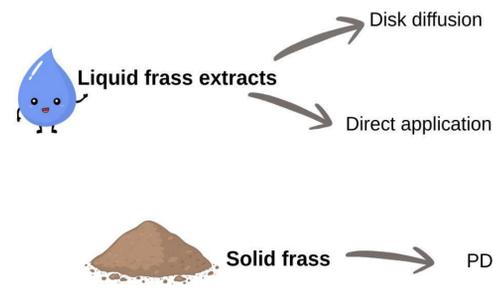
This study combined *in vitro* and *in planta* experiments using tomato plants

In vitro assays

- Liquid frass extracts (autoclaved (FRA) / non-autoclaved (FR))
- Disk diffusion & direct application methods
- Controls: fungicide (FUN) & pH-adjusted solutions (CPH)
- PDA medium amended with 1% solid frass

In planta assays

- Substrate supplemented with **1% frass**
- Artificial inoculation with *Rhizoctonia solani*
- Evaluation of disease symptoms & growth parameters



RESULTS & DISCUSSION

In vitro assays

Fusarium oxysporum

- No antifungal activity detected
- No significant differences between frass treatments (FR / FRA) and negative controls

Rhizoctonia solani

✓ Mayor antifungal activity observed in **solid medium assays, 38% growth reduction at Day 3** ($p < 0.001$)

In planta assays

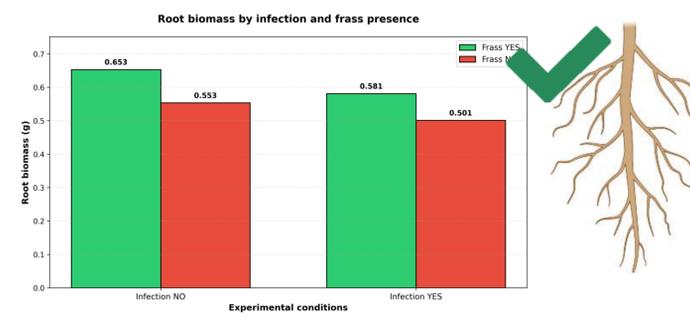
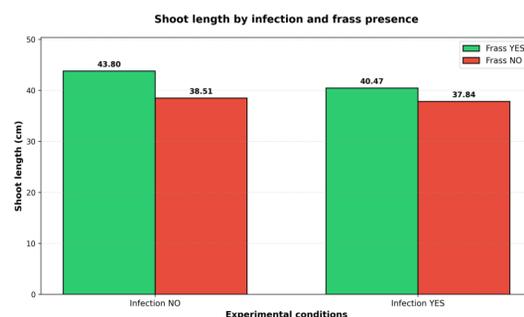
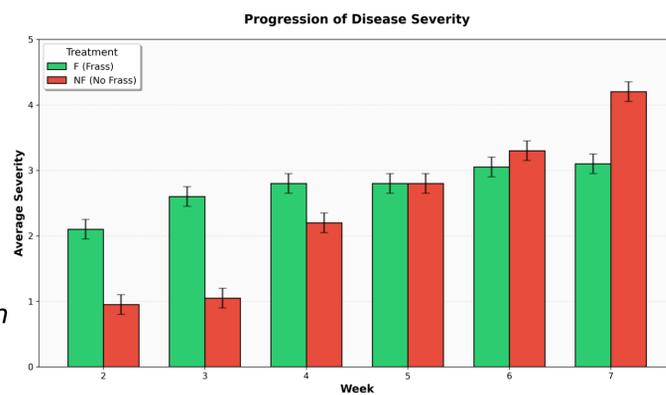
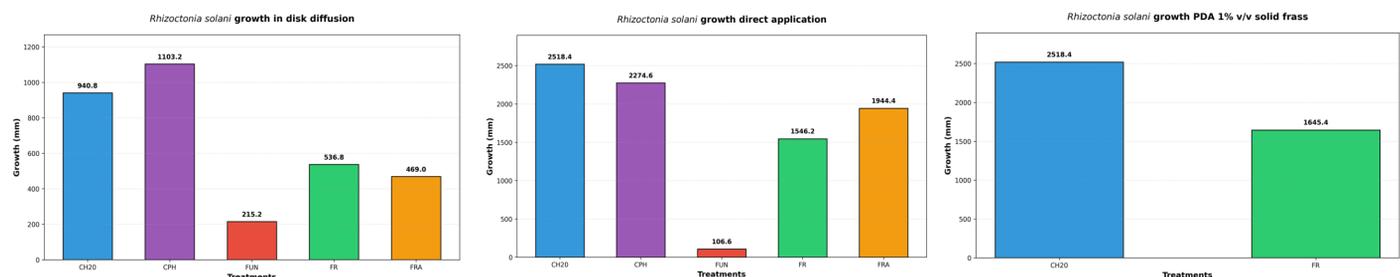
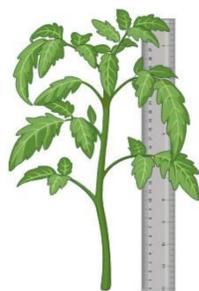
✓ Frass amendment influenced disease development and plant performance

- Plants grown in frass-amended substrate showed reduced disease symptoms under *Rhizoctonia solani* infection

✓ Growth-promoting effects were observed

Compared with non-amended plants:

- Increased root biomass
- Enhanced shoot development
- ✓ **Shoot elongation response**
- Infected plants → +2.63 cm
- Non-infected plants → +5.29 cm



Frass extract efficacy depended on the pathogen and application method

Solid frass can mitigate the impact of *Rhizoctonia solani* disease

Solid frass promote plant growth

REFERENCES:

Zunzunegui I, Martín-García J, Santamaría Ó, Poveda J (2024) Analysis of yellow mealworm (*Tenebrio molitor*) frass as a resource for a sustainable agriculture in the current context of insect farming industry growth. *J Clean Prod* 449:142608. <https://doi.org/10.1016/j.jclepro.2024.142608>

Zunzunegui I, Martín-García J, Santamaría Ó, Poveda J (2025) Insect frass as an agricultural resource against abiotic and biotic crop stresses: mechanisms of action and possible negative effects. *Appl Sci* 15:3606. <https://doi.org/10.3390/app15073606>