

Insects' Frass as a Nematicidal Tool Against *Meloidogyne Incognita*

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Background & Objective

- **Background:** Root-knot nematodes (RKN) are a major global constraint on horticultural and field crops. *Meloidogyne incognita* is a particularly destructive species that causes root galling, reduced nutrient uptake and yield loss
- **Current Status:** Traditional control relies on synthetic nematicides, which are currently under heavy environmental and regulatory scrutiny.

Objective:

Objective: To synthesize evidence on insect frass (a byproduct of commercial insect rearing) as a dual-function amendment for:

1. Nematode suppression.
 2. Soil health improvement.
- The research also aims to highlight gaps for future field deployment.

Mechanistic Pathways

Direct antagonism: Bioactive metabolites and antimicrobial peptides may impair juveniles and egg viability. **Microbial stimulation:** chitin promotes chitinase-producing microbes, shifting the rhizosphere toward suppressiveness. **Plant-mediated effects:** improved nutrition and defense priming can reduce infection success. **Soil conditioning:** organic inputs improve structure, water retention, and microbial activity.

Main Research Findings

Frass from black soldier fly, mealworms, and crickets contains chitin, chitosan-related fractions, antimicrobial peptides, and secondary metabolites with reported nematicidal activity. Chitin-rich residues can stimulate indigenous chitinolytic microorganisms, potentially weakening nematode egg shells and juvenile cuticles. Nutrient-rich frass can enhance plant vigor and may activate induced systemic resistance, indirectly lowering nematode parasitism. Studies report reductions in juvenile penetration, galling intensity, and reproductive capacity; efficacy varies with insect species, rearing substrate, processing, soil type, and dose

Key Study Gaps

Identify active molecules and quantify their persistence in soils. Standardize production (insect species, substrates, processing, storage) to reduce variability. Optimize formulations (granules, pellets, extracts) and field rates across soil types. Test compatibility with IPM components (biocontrols, cover crops, solarization, reduced-risk chemistries). Evaluate non-target effects, phytotoxicity at high rates, and economic feasibility.

Evidence Snapshot

Frass component / property	Proposed contribution to RKN suppression
Chitin & chitin-derived fractions	Stimulates chitinolytic microbes; may weaken egg shells and juvenile cuticles
Antimicrobial peptides	Direct toxicity or stress effects on juveniles; influences microbial community balance
Nutrients & organic matter	Improves plant vigor and root recovery; supports beneficial microbial activity
Secondary metabolites	Potential direct antagonism and signaling effects; varies by insect and substrate
Physical soil improvement	Better structure and moisture buffering; supports suppressive soil conditions



Conceptual pathways linking frass to nematode suppression (not to scale)

Take-home message: Insect frass is a promising circular-economy amendment that may suppress RKN through combined biochemical, microbial, and plant-mediated pathways. Adoption will require standardized products, mechanistic validation, and multi-site field studies.

Keywords: Root-knot nematodes; insect frass; chitin; chitinolytic microbes; systemic resistance; sustainable agriculture; circular bioeconomy

Application Approaches

