Proposal for Nursery Research Grant Program 2026 Request

Title: Biopesticides for thrips control in horticultural and nursery crops

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Background: In Oregon, the nursery industry, including Christmas trees generates nearly $1.4 billion annually (ODA, 2022), yet it faces a persistent and costly threat: thrips. These tiny insects consistently rank among the most destructive pest challenges, inflicting direct damage on hundreds of host plants, including many high-value ornamental and nursery crops. Beyond physical damage, thrips also serve as vectors of devastating plant viruses such as tomato spotted wilt virus and impatiens necrotic spot virus, amplifying their economic impact across both the nursery and horticultural crop industries.

Among thrips species, western flower thrips (WFT), *Frankliniella occidentalis*, is the most destructive and economically significant pest. Extensive research has documented its species complex and biological aspects, including feeding and oviposition behaviors, control options, and resistance to chemical insecticides. Because of their extremely small size and broad host range, detecting and preventing the spread of WFT is highly challenging. Current control methods primarily rely on conventional chemical insecticides, which can negatively impact human and environmental health and contribute to pesticide resistance. Therefore, it is essential to develop appropriate management strategies that emphasize biopesticides as environmentally friendly alternatives.

Our research leverages cutting-edge molecular tools—such as genomics, proteomics, and transcriptomics—to identify bioactive peptides (small protein molecules) with the potential to serve as the basis for thrips-specific biopesticides. The target-specific approach offers the potential to reduce reliance on conventional chemical pesticides while enhancing the effectiveness and sustainability of crop protection strategies.

Technology: For decades, insect neuropeptide hormones and their receptors, G-protein coupled receptors (GPCRs), have been offered biological targets for new insect pest control methods, because they are involved in many essential biological processes in insects. PI, Dr Choi, developed a novel GPCR-based insecticide discovery method to identify bioactive peptides. The first proof-of-concept for the technology is called Receptor interference (Receptor-i). Receptor-i has been patented (U.S. Patents 9,771,393 – 2017; and 10,017,538 B2 – 2018), and the research results have been published (2021; 2023). The technology is now being expanded to other pests, including slug, thrips, spotted-wing drosophila, lygus, and the moth. Receptor-i technology is generally applicable to all animal pests.

Thrips-related works: 1) established a new rearing method for thrips and a DNA marker for molecular identification for thrips species (2022, *https://doi.org/10.1653/024.105.0211)*; 2) developed a nano-injection system for micro insects (<2mm) using WFT model for delivery biological compounds into thrips (2022, *https://doi.org/10.1111/jen.13063*); 3) identified the thrips neurohormones as biological targets for thrips control (2023, *https://doi.org/10.1111/imb.12859*); 4) identified WFT pheromone biosynthetic mechanism (2023; *https://doi.org/10.1038/s41598-023-32833-9*); 5) reported a new approach for thrips management (Digger, March 2025); 6) filed a US patent (2024, Application No. 18/802,427) regarding bioactive peptides for thrips control; 7) identified thrips receptors as biological targets (2025, submitted to a peer-reviewed journal).

Projective objectives and outcomes: We evaluated over 20 peptides (small protein molecules), including structurally modified variants, against adult thrips using injection and feeding tests. Some cyclized peptides (circular peptides) modified from native sequences (see **Fig. 1**) demonstrated insecticidal effects, reducing thrips survival after feeding (peer-reviewed publication in preparation, 2025). The stability of peptides, as active ingredients of biopesticides, is critical for effective delivery into the insect body and for enhancing insecticidal activity. In this proposal, we aim to increase the stability of peptides and evaluate their insecticidal activity after oral ingestion by thrips. The following specific objectives will be addressed in this study.

1. Design and synthesis of internally cyclized peptides.
2. Feeding of bioactive peptides to thrips and evaluation of insecticidal effects.

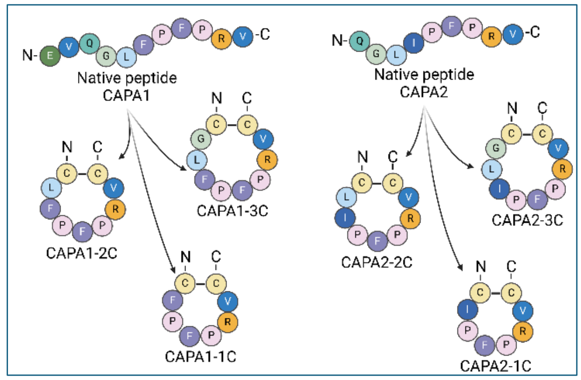

Figure 1. The amino acid sequences of the bioactive peptides include two native peptides (linear forms), CAPA1 and CAPA2, as well as six cyclic peptides derived from CAPA1 and CAPA2. The cyclic peptides were generated by introducing two cysteine residues that form disulfide (C–C) bonds between the N- and C-terminal ends.

We focus specifically on identifying bioactive peptides with insecticidal properties, as these protein molecules interfere with a variety of biological processes throughout their life stages. Therefore, successful achievement of our study will contribute to the development of a novel biopesticide for thrips control and protect nursery crops. Furthermore, the outcomes are expected to address fundamental requirements for applying biocontrol strategies to other insect pests.

Methods and Timeline

1. Design and synthesis of internally cyclized peptides (0.4yr): From the native CAPA peptide, CAPA2, will be modified variant peptides containing internally cyclized C-C bonds within the peptide sequences, rather than disulfide bonds (C–C) between the N- and C-terminal ends (**Fig. 1**). If necessary, we will analyze hydrophobicity and hydrophilicity of the peptides using peptide tools. All the bioactive peptides (>20 peptides) used in this study will be synthesized at a purity greater than 95%.

2. Feeding of bioactive peptides to thrips and evaluation of insecticidal effects (0.6 yr): Thrips (2-5-day old) will be starved for 1 hour and then fed 1µl of a 1% sucrose solution containing 10 nmol of bioactive peptide and mortality will be checked daily up to two weeks (see **Fig. 2**). The solution will normally last 5 days and will be replaced with fresh solution, but will be checked daily to decide whether to replace the droplet before or after 5 days. Water only and unrelated nematode peptide solution will be used as negative controls. Survival rates will be compared between treatments using log-rank analysis.

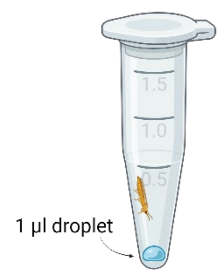

Figure 2. Feeding of peptide solution to thrips.

Budget Request

[1]Salary& OPE	[2]Travel	[3]Materials & Supplies	Total
$25,920	$800	$5,500	$32,220

1. Wages & OPE ($25,920): $16.50/hour × 30 hours/week × 52 weeks = $25,740 + $180 OPE
2. Travel ($800): Supports student travel to present at entomological meetings
3. Materials & Supplies ($5,500): Cyclized synthetic peptides: $450 × 10 = $4,500; Thrips rearing supplies: soybean seeds, dishes, fertilizer, and bedding = $1,000

This project will be supported by the USDA base fund and other grants.