Pre-Tenure Leave Application

Name: Angela Peverly Date: 10/1/25

Department(s) or School(s): Chemistry and Biochemistry

First Year Appointed to a Tenure Line: 23-24 Year of Tenure Consideration: 29-30

Have you applied for a Pre-Tenure Leave before? If yes, when? No

Leave Requested for: *(check one & fill in the year)* Fall ☐ Spr. ☑ of Academic Year 27

A) If your proposal is funded, would you be willing for the Thorpe Center to use it as an exemplary submission in the online Handbook? • Yes ☑ •No ☐

B) Would you like to be considered for the Gardner Faculty Scholars Award? • Yes ☑ • No ☐

C) Will you use human beings as experimental subjects? • Yes* ☐ • No ☑

*If yes, please submit the appropriate approval notice.

If you have questions about whether IRB approval or exemption is required for your project, please see the pdf link on "Policies and Procedures" at https://www.iwu.edu/irb/forms/IRB_PolicyProcedure.pdf.

D) Will you use animals as experimental subjects? ▪ Yes* ☐ ▪ No ☑

a) *If so, have you requested IRB and/or IACUC approval? • Yes** ☐ • No ☐

***If yes, please submit the appropriate approval notice.*

(See the IACUC link to protocol forms at https://www.iwu.edu/associateprovost)

Please complete the following checklist by placing a check mark against each item to ensure that your application is complete. Please note that incomplete and/or late applications will be returned without evaluation.

1. Summary of Project (emailed to fdc@iwu.edu) ☑
2. Proposal as per format described in Handbook ☑
3. A brief Vita ☑
4. Supervisor/Recommender Letter ☐

Please give the name and email address of the immediate supervisor.

Name: Dr. Ram Mohan Email: rmohan@iwu.edu

Pesticides on the Surface and Within Cut Flowers

A. End Product

This project will result in several key academic products. The primary product will be a validated analytical method for the detection and quantification of a range of pesticides, with a specific focus on application to flower matrices. While the method will be developed with flexibility for potential use across various sample types, its validation and initial implementation will concentrate on floral samples, which remain relatively underrepresented in environmental monitoring and ecological risk assessment. In addition to the methodological advancement, the project will generate at least two peer-reviewed publications in respected environmental chemistry journals, disseminating the findings and contributing to the broader scientific community. Furthermore, the research will be presented at local, regional, and national chemistry and environmental science conferences, providing opportunities for scholarly engagement and professional development for both the principal investigator and participating students.

B. Scholarly Significance of the Project

B.i. Nature of the Problem

Pesticides play a critical role in modern agricultural practices by managing pest populations and enhancing crop yields, thereby supporting the global demand for food production and the cultivation of ornamental plants. Their widespread use has contributed significantly to agricultural efficiency and the stability of supply chains. However, the extensive application of pesticides has also sparked increasing concern within the scientific community regarding their long-term environmental and human health impacts.

According to the United States Environmental Protection Agency (EPA), pesticides are defined as

> "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant, or any nitrogen stabilizer" (1).

This definition encompasses a wide range of chemical agents, including herbicides, insecticides, fungicides, rodenticides, disinfectants, repellents, and plant growth regulators. These substances are typically designed for specific applications but share the overarching objective of minimizing pest-induced agricultural losses and optimizing productivity. Their effectiveness has led to the mass usage of pesticides.

Globally, the use of pesticides exceeds 4 million metric tons annually, with the United States consistently ranking among the highest consumers (2). While the benefits of pesticide use are well-documented, particularly in terms of crop protection and yield maximization, their widespread and often indiscriminate application has led to a growing body of evidence indicating adverse environmental and health effects. Pesticide residues have been detected in various environmental media, including air, surface water, groundwater, soil, and even within plant tissues (3,4,5,6).

Of particular concern are the toxicological properties of many pesticide compounds. Several are classified as carcinogens and have been shown to interfere with endocrine function, reproductive health, genetic integrity (genotoxicity), and neurological processes (7,8). Populations with frequent or prolonged exposure, such as agricultural workers and residents living near treated fields, are at elevated risk for developing a range of health problems, including respiratory ailments, hormonal imbalances, neurological disorders, and certain forms of cancer (3,9,10,11).

B.ii. Scholarly Context Applicant is Addressing

This study will focus on the detection and quantitation of pesticides both on the surface and within the tissues of cut flowers. In 2024, the cut flower industry in the United States was valued at approximately $71 billion (12). One of the primary motivations for this research is the inconsistency in pesticide regulations across countries. Certain chemical substances may be banned or restricted in the United States and the European Union, but remain permissible in other nations. These countries may serve as exporters of flowers to the U.S., potentially introducing pesticide residues that are otherwise regulated or prohibited domestically.

Lan et al. (13) identify flowers as "the most pesticide-intensive crop," noting that growers often apply large quantities of chemical pesticides, including substances that are toxic and banned in some regions. Additionally, Pereira et al. (9) highlight the lack of established criteria for pesticide application in ornamental horticulture, particularly regarding maximum residue limits (MRLs), which remain undefined in many countries.

Human exposure to pesticides primarily occurs through inhalation, ingestion, and dermal contact. This study will therefore examine both surface residues that can be removed through washing, as well as internal residues absorbed into plant tissue. Analysis of surface residues may provide insight into potential exposure risks for floriculture workers, especially through inhalation and skin contact. In contrast, internal pesticide concentrations may offer information about the environmental fate of these chemicals, particularly their potential entry into water systems or landfills through discarded plant material.

The initial phase of this research will focus on carnations, a widely distributed and commercially important cut flower. Carnations are frequently sold in supermarkets, used extensively by florists, and cultivated in various regions, making them an ideal candidate for preliminary investigations. This foundational analysis will support the development of broader comparative studies across different flower species and production systems.

B.iii. Methodology to be Used

The method used for analyzing pesticide residues in most matrices involves fives key steps: sample acquisition and preparation, extraction, clean-up, concentration, and analysis using gas chromatography-mass spectrometry (GC/MS).

Sample Acquisition and Preparation:

Flowers will be procured from commercial retailers, with details recorded regarding their place of purchase and country of origin. Additional information, such as whether the flowers were cultivated using conventional or organic farming practices, their age at the time of purchase, and the conditions of storage and transport, will be collected where possible. While

full traceability may be limited, all available information will be documented. Ideally, flower samples will be analyzed within 24 hours of purchase.

To analyze surface residues, flowers will be labeled and rinsed with a suitable solvent. The resulting wash solution will be collected and stored in glass containers for further analysis. For internal residue analysis, flowers will be chopped into small pieces and also stored in clean glass containers. If immediate analysis is not feasible, all samples will be refrigerated at 4 °C until processing.

Extraction:

Pesticide extraction will be carried out using the VELP SER 158 Automatic Solvent Extractor, a system that provides a faster and more solvent-efficient alternative to traditional Soxhlet extraction methods. A schematic of the extraction process is shown in Figure 1, where the yellow color represents the solvent and the red indicates the presence of pesticides.

Samples will be loaded into cellulose thimbles, which are then placed in extraction flasks containing the extraction solvent. The system proceeds through a five-step process:

1. Immersion (Figure 1, Step 1): The samples are immersed in boiling solvent for a specified period to initiate extraction.
2. Solvent Removal (Figure 1, Step 2): A portion of the solvent is removed and stored.
3. Washing (Figure 1, Step 3): The remaining solvent refluxes through the sample, further extracting pesticide residues. At this stage, the pesticides migrate from the sample matrix into the solvent in the extraction flask.
4. Solvent Recovery (Figure 1, Step 4): The solvent is recovered and condensed, allowing for reuse and concentrating the extracted pesticides in a reduced solvent volume. This step will be closely monitored to ensure that pesticide residues remain in the extraction flask and are not lost to the solvent recovery unit.
5. Cooling (Figure 1, Step 5): The final extract, containing concentrated pesticide residues, is cooled and stored for subsequent analysis.

This extraction method offers an efficient and reproducible approach for isolating pesticide residues from both surface washes and internal flower tissues.

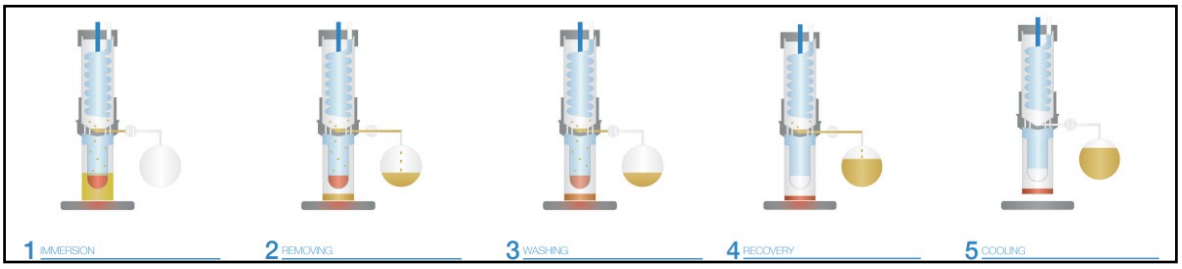

Figure 1: Extraction process with the VELP SER 158 Automatic Solvent Extractor, which includes immersion, removing, washing, recovery, and cooling steps (acquired picture from 14)

Following extraction, the solvent contains the target pesticide compounds along with other co-extracted substances that partition into the solvent. To isolate the analytes of interest, a clean-up step is necessary. One of the primary groups of interfering compounds includes lipids,

which can be effectively removed using column chromatography. In this step, a column will be packed with an adsorbent material designed to retain unwanted matrix components, allowing the target pesticides to elute through the column.

After the clean-up stage, the extract must be concentrated to a smaller volume to facilitate compound detection and quantification. Initial concentration will be performed using rotary evaporation. Following this, samples will be spiked with an internal standard, which is used for quantification of the target compounds. A final concentration step will then be carried out using a stream of nitrogen gas to further reduce the sample volume.

The concentrated extracts will be analyzed using gas chromatography–mass spectrometry (GC/MS). In this technique, a small aliquot of the liquid extract is injected into the GC inlet, where it is vaporized. The vaporized sample then travels through a capillary column, where individual compounds are separated based on their boiling point, molecular size, and functional groups. The column is housed within a temperature-controlled oven, which utilizes a programmed temperature gradient to enhance separation efficiency.

As compounds elute from the GC column, they enter the mass spectrometer, where they are ionized and subsequently separated according to their mass-to-charge (m/z) ratios. This allows for both the detection and quantification of the analytes.

Chromatographic signals will be obtained as shown in Figure 2. Peak areas corresponding to the analytes will be compared against calibration standards containing the same internal standard to determine compound concentrations. All analyses will be conducted in triplicate, and the method will include procedural blanks and spiked blanks to validate accuracy, precision, and reproducibility.

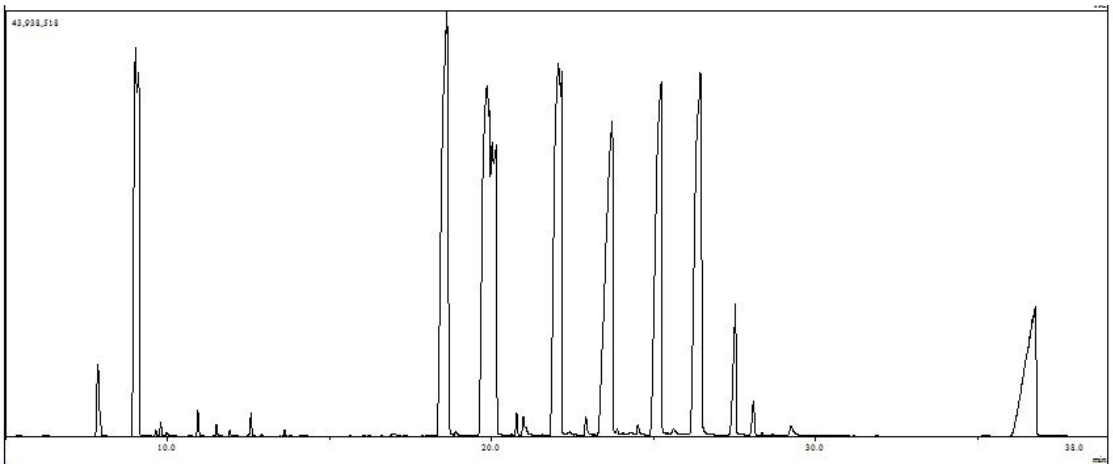

Figure 2: Gas chromatogram of EPA 8270 Organophosphorus Pesticide Mix 2 (Supleco) acquired by Illinois Wesleyan University's GC/MS utilizing the GC/MS program from Yang et.al. (15).

B.iv. Contribution the Applicant Expects to Make With the Project

While considerable research has been conducted on pesticide residues in fruits, vegetables, soils, and air, relatively little attention has been given to pesticide contamination in cut flowers. A recent 2025 study noted that "research on CUP [current use pesticides] residues in blossoms remains limited" (4). In that study, 47 different CUPs were detected in flower samples collected

from Germany (4). Similarly, Lan et al. (13) reviewed multiple publications and confirmed the presence of pesticides in cut flowers; however, their review did not include quantitative data on residue levels.

Furthermore, a review article on pesticide production and human exposure reported that pesticide use in ornamental horticulture poses significant health risks to individuals across the floriculture supply chain, including farmers, vendors, and local residents living near cultivation sites (9). These findings underscore the urgent need for further investigation into pesticide residues in flowers, a topic that remains underrepresented in current environmental and occupational health research.

With the publication of at least two peer-reviewed articles and presentations at multiple scientific conferences planned, this research has the potential for substantial academic and industry impact. A deeper understanding of pesticide residues in cut flowers could improve awareness among floriculture workers regarding their occupational exposures and may also contribute to a broader understanding of pesticide persistence in the environment, particularly in aquatic systems.

C. Professional Significance of the Project

This leave will provide a vital opportunity to fully dedicate my time to research, allowing for uninterrupted focus on a project that requires sustained attention and sequential experimentation. The complexity of this research, encompassing sample acquisition, extraction, clean-up, and analysis, demands substantial blocks of time that are typically not feasible within the constraints of a full teaching load.

Importantly, this project marks a re-entry into active research after a nine-year period during which I worked at a teaching-focused institution with limited resources to support faculty-led scientific investigation. The leave will enable me to re-engage with current developments in the field of environmental chemistry and pesticide residue analysis, while updating my technical skills and expanding my familiarity with recent literature and methodologies. This renewed scholarly engagement is essential for rebuilding my research profile and aligning my expertise with contemporary challenges in agricultural and environmental sciences.

In addition to completing this study, I intend to use this time to build a foundation for future research collaborations. For example, one promising extension of this work would involve investigating whether pesticide residues leach from cut flowers into the water in which they are stored, an important but understudied pathway of environmental contamination. Identifying collaborators for such interdisciplinary projects would further enhance the impact of my research and contribute to a long-term, sustainable research agenda.

Overall, this leave represents a critical juncture in my professional development, offering the time and space necessary to reestablish myself as a productive scholar, develop new lines of inquiry, and contribute meaningfully to both the scientific community and my institution's research culture.

D. Proposed Timetable

By January 2027, all target compounds will be identified in the GC/MS data, with established retention times and quantifying ions. The analytical method will be fully developed for GC/MS, including optimization of inlet temperature, oven temperature program, transfer line temperature, ion source temperature, and mass spectral ion selection.

By February 2027, the extraction method will be validated for all target compounds, ensuring reliable recovery and reproductivity across sample preparations.

By April 2027, the validated method will be applied to the analysis of carnations, including both the residue analysis and the whole flower analysis, to evaluate pesticide presence and concentration.

By May 2027, all experimental data will be analyzed, and manuscripts will be prepared and submitted for publication in peer-reviewed environmental chemistry journals.

During this semester, calls for submission to relevant scientific conferences will also be monitored, with the goal of presenting the research findings at local, regional, and national meetings.

E. IRB/IACUC Review

Not Applicable

F. References

1. U.S. Environmental Protection Agency. *What Is a Pesticide?* (Minimum Risk Pesticides); U.S. EPA, February 13, 2025. https://www.epa.gov/minimum-risk-pesticides/what-pesticide (accessed Sept 15, 2025).
2. Food and Agriculture Organization of the United Nations. *Pesticides Use (FAOSTAT)*; FAO. https://www.fao.org/faostat/en/#data/RP (accessed Sept 15, 2025).
3. Van Der Werf, H. M. G. Assessing the Impact of Pesticides on the Environment. *Agric. Ecosyst. Environ.* **1996**, *60* (2–3), 81–96. https://doi.org/10.1016/S0167-8809(96)01096-1
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5. Aktar, W.; Sengupta, D.; Chowdhury, A. Impact of Pesticide Use in Agriculture: Their Benefits and Hazards. *Interdiscip. Toxicol.* **2009**, *2* (1), 1–12.
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10. Alavanja, M. C. R.; Ross, M. K.; Bonner, M. R. Increased Cancer Burden among Pesticide Applicators and Others Due to Pesticide Exposure. *CA Cancer J. Clin.* **2013**, *63* (2), 120–142. https://doi.org/10.3322/caac.21146
11. Bassil, K. L.; Vakil, C.; Sanborn, M.; Cole, D. C.; Kaur, J. S.; Kerr, K. J. Cancer Health Effects of Pesticides: Systematic Review. *Can. Fam. Physician* **2007**, *53* (10), 1704–1711.
12. Society of American Florists. Floral Industry Facts. *Society of American Florists*. https://safnow.org/trends-statistics/floral-industry-facts/ (accessed Oct 06, 2025).
13. Lan, Y.-C.; Tam, V. W. Y.; Xing, W.; Datt, R.; Zhang, L.; Wang, Y. Life Cycle Environmental Impacts of Cut Flowers: A Review. *J. Clean. Prod.* **2022**, *369*, 133415. https://doi.org/10.1016/j.jclepro.2022.133415
14. VELP Scientifica. VELP SER 158 Automatic Solvent Extractor; VELP Scientifica: 2023; https://www.velp.com/public/file/VELPSER158ENrev06-316614.pdf (accessed Oct 1, 2025).
15. Yang, X.; Zhang, H.; Liu, Y.; Wang, J.; Zhang, Y. C.; Dong, A. J.; Zhao, H. T.; Sun, C. H.; Cui, J. Multiresidue Method for Determination of 88 Pesticides in Berry Fruits Using Solid-Phase Extraction and Gas Chromatography–Mass Spectrometry. *Food Chem.* **2011**, *127* (2), 855–865. https://doi.org/10.1016/j.foodchem.2011.01.024

ANGELA PEVERLY

EDUCATION

Ph.D. in Analytical Chemistry and Minor in Environmental Science 2013
Indiana University, Bloomington, Indiana
Thesis: Environmental Electrochemistry: Remediation of Halogenated Organic Pollutants
Advisor: Dennis Peters, Ph.D.

B.S. in Chemistry, *Cum Laude* 2008
Benedictine University, Lisle, Illinois
Thesis: Development and Optimization of a Glucose Oxidase-modified Rotating Disk Electrode for Amperometric Detection of β-D-glucose
Advisor: Niina Ronkainen, Ph.D.

TEACHING EXPERIENCE

Illinois Wesleyan University, Bloomington, Illinois 2024–present
Assistant Professor of Chemistry and Biochemistry

Eureka College, Eureka, Illinois 2020-2024
Associate Professor of Chemistry
Assistant Professor of Chemistry 2015–2020

Heartland Community College, Normal, Illinois 2020–2024
Adjunct Instructor I

RESEARCH EXPERIENCE

Indiana University, Bloomington, Indiana
Post-Doctoral Associate 2013–2015
Detected and quantitated levels of pesticides, polycyclic aromatic hydrocarbons, polybrominated diphenyl ethers, and organophosphorous flame retardants in environmental samples with gas chromatography and mass spectrometry. Developed methodology for sample extraction and analysis and maintained instrumentation.

Research Assistant 2009–2013
Developed and optimized an electrochemical method for the determination of trihalomethanes in drinking water by stripping analysis and investigated the electrochemical reduction of various halogenated organic pollutants including lindane, decabromodiphenyl ether, and hexabromocyclododecane.

Benedictine University, Lisle, Illinois
Benedictine University Natural Science Summer Research Internship 2006, 2007
Examined and optimized an electrochemical glucose oxidase biosensor.

DuPage County Crime Laboratory
Internship 2007
Cataloged infrared spectra (IR) for various illegal substances.

PUBLICATIONS (a select few)

Peverly, A. A.; Salamova, A.; Hites, R. A. Environ. Sci. Technol. **2015**, 49, 13743–13748, "Locating POPs Sources with Tree Bark"

Peters, D. G.; McGuire, C. M.; Pasciak, E. M.; Peverly, A. A.; Strawsine, L. M.; Wagoner, E. R.; Barnes, J. T. *J. Mex. Chem. Soc*. **2014**, 58, 287–302, "Electrochemical Dehalogenation of Organic Pollutants"

Peverly, A. A.; Salamova, A.; Hites, R. A. *Environ. Sci. Technol*. **2014**, 48, 11154–11160, "Air is Still Contaminated 40 Years after the Michigan Chemical Plant Disaster in St. Louis, Michigan"

PRESENTATIONS (a select few)

October 2025, ACS 2025 Midwest Regional Meeting, Columbia, MO; Huenecke, A.; Dial, A.; Rangel, F.; Peverly, A., Method Development and Quantitative Analysis of Pesticides using Automatic Solvent Extraction, Column Chromatograph, and GC/MS, poster presentation

October 2025, ACS 2025 Midwest Regional Meeting, Columbia, MO; Mustafa, S.; Peverly, A., Heavy Metal Method Development and Analysis in Fruits and Vegetables using Flame Atomic Absorption, and Graphite Furnace Atomic Absorption, poster presentation

November 2015, SETAC North America 36th Annual Meeting, Salt Lake City, UT; Peverly, A. A.; Salamova, A.; Venier, M.; Hites, R. A., Concentrations and Trends of Organophosphate Esters in the Great Lakes Atmosphere, poster presentation

May 2012, 221st ECS Meeting, Seattle, WA; Peverly, A. A.; Peters, D. G., Electrochemical Determination of Trihalomethanes in Drinking Water by Stripping Analysis, oral presentation

February 2007, 58th Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy, Chicago, IL; Peverly A. A.; Ronkainen-Matsuno, N. J., Development and Optimization of a Glucose Oxidase-modified Rotating Disk Electrode, poster presentation

THESIS ADVISOR (a select few)

Savannah Hack, Eureka College, Honors Thesis, "Novel Yarn Analysis by Evenness Testing" 2023
Drew Cummings, Eureka College, Honors Thesis, "Burnout in Healthcare: Analysis on the Cause and Effects Along with the Prevention of Burnout in Healthcare Workers" 2023
Katherine Germann, Eureka College, Honors Thesis, "Professional Medical Interpreters and the Barriers to Following Cultural and Linguistically Appropriate Service Standards" 2020

PROFESSIONAL MEMBERSHIPS

American Chemical Society	2006-present
Society of Environmental Toxicology and Chemistry	2013–2015

AWARDS (a select few)

Women in Chemistry Travel Award (from Indiana University Women in Chemistry)	2012
Indiana University Graduate Fellowship	2008
I. M. Kolthoff Enrichment Award for Undergraduate Students	2008