Eco-Friendly Innovation in Ornamental Tree Care: Assessing the Efficacy of Natural Pest and Disease Control Treatments

Ashjan Hindi

Instructor: Safiah Mohammad

Supervisor:

Roaa Hindi

BS Biomedical Engineering

University of Toledo

MS of Artificial Intelligence

Lawrence Technological University

Abstract

Ornamental trees greatly contribute to the aesthetic appeal of landscapes, they are frequently susceptible to a variety of pests, illnesses, and environmental stresses. This study investigates the possibility of combining flavonoids and glucosinolates, two substances originating from plants, to create an easy, environmentally friendly ornamental tree treatment. While flavonoids improve stress tolerance and have antioxidant effects, glucosinolates have antibacterial and insecticidal qualities. The study suggests an easy-to-use remedy that may be made and used at home, such a Bandage.

This strategy seeks to lessen dependency on synthetic chemicals while also promoting sustainable and organic tree care. While its advantages include environmental friendliness, cost-efficiency, and broad applicability, issues such as limited research on ornamental trees and potential variability in performance must be addressed. With further refinement, this technology may provide a natural and accessible alternative for preserving the health and longevity of ornamental trees.

Keywords

Ornamental trees, Glucosinolates, Flavonoids, Pest and disease management,

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1. Introduction

1.1 Background and Problem Statement

Ornamental trees are planted solely for their aesthetic appeal, and they play an important role in landscaping, gardens, parks, and urban green spaces. These trees, which include ornamental cherry, Japanese maple, and ficus, are selected for their visually appealing characteristics such as bright blossoms, colorful foliage, textured bark, and distinctive overall shapes. However, these trees are vulnerable to a variety of biotic and abiotic challenges, including insect pests, fungal infections, and climatic extremes such as drought and high heat. Traditional pest and disease management approaches rely mainly on chemical pesticides and fungicides, which have serious environmental and health consequences.

There are current treatment strategies for ornamental trees include both preventive and reactive methods:

Chemical treatments include pesticides and fungicides, which are commonly used to manage insect infestations and fungal infections. However, excessive use can affect both the environment and non-target creatures.

Cultural practices such as proper watering, mulching, trimming, and fertilizing enhance tree resilience and general health.

Promoting biodiversity, such as importing natural insect predators, is a sustainable pest control approach.

Biological control agents include beneficial microorganisms like mycorrhizal fungi and soil bacteria that support tree growth and guard against infections.

Plant-based remedies, such as essential oils and extracts, are increasingly popular due to their low environmental impact.

1.2 Previous Research and Gaps

Chemical pesticides have long been the accepted technique of controlling pests and diseases in ornamental trees. However, there is rising worry about these compounds' harmful effects on the environment. Pesticides can contaminate soil and water, as well as affect non-target creatures like pollinators, birds, and beneficial insects. These issues have sparked interest in environmentally friendly alternatives, notably those produced from plants.

Plant-Derived Compounds for Pest Control

Several studies have shown that plant-based chemicals are effective for insect control. For example, essential oils, plant extracts, and resins from diverse plants have been shown to have insecticidal, antifungal, and antibacterial activities.

Isman (2006) investigated the potential of essential oils such as citronella, neem, and eucalyptus in pest management, finding that they could considerably lower pest populations while being less hazardous to the environment than synthetic pesticides.

Similarly, Hossain et al. (2013) tested the effects of neem oil on insect populations in agricultural settings and discovered that it effectively repels aphids and whiteflies. Neem oil has been demonstrated to block the reproduction of a variety of insect pests, making it a promising long-term pest management solution. Another study conducted by Koul et al.

(2008) emphasized the promise of plant-derived insecticides, emphasizing on natural chemicals such as pyrethrins and rotenone, which are known to be nontoxic to humans and animals while effective against a wide range of pests.

In addition to pests, several plant extracts have antibacterial effects. Rattanawalee et al. (2014) investigated the antifungal properties of plant extracts such as garlic, ginger, and turmeric, revealing their potential to control common fungal diseases in ornamental plants. This shows that plant-based medicines may be successful against fungal infections that typically damage ornamental trees.

1.3 Research Objective

- **Glucosinolates**

Glucosinolates, present in plants like broccoli, cabbage, and mustard, can repel pests like aphids, caterpillars, and beetles. These sulfur and nitrogen-containing compounds, found largely in the Brassicaceae family, consist of a β-D-thioglucose group connected to a sulfonated aldoxime moiety and a variable amino acid-derived side chain. When tissue is damaged, the enzyme myrosinase hydrolyzes glucosinolates, resulting in physiologically active compounds such as isothiocyanates, nitriles, and thiocyanates, which have antibacterial and insecticidal effects. This shows that glucosinolate-rich materials, such as those employed in biofumigation, could be useful treatments for pest and disease control in ornamental trees. Isothiocyanates, in example, have been found to reduce pathogen growth and repel herbivorous insects.

- **Flavonoids**

Flavonoids, a type of polyphenolic chemical found in fruits, vegetables, and teas, have antioxidant capabilities and help plants fight stress and illness. Flavonoids are made up of two aromatic rings connected by a three-carbon bridge to form a heterocyclic ring. They are divided into four subclasses: flavones, flavonols, flavanones, and anthocyanins. Flavonoids also serve an important function in plant defense, limiting microbial development and neutralizing reactive oxygen species created during environmental stress. Flavonols, in example, have been demonstrated to alter glucosinolate and camalexin biosynthesis, hence influencing a number of plant defense metabolic pathways. While these chemicals have been examined independently for their specific contributions to pest control and plant health, their combined potential as remedies for ornamental trees is mostly unexplored.

The main objective of this research is to explore the potential of combining glucosinolates and flavonoids into an easy-to-use Bandage for ornamental trees. These two natural compounds, derived from plants, have shown remarkable properties in boosting plant health, protecting against pests, and improving resistance to diseases. The idea is to create a simple, environmentally friendly combined treatment bandage and applying it to selected ornamental trees treatment that homeowners or gardeners can easily apply to their ornamental trees.

By utilizing these compounds' natural defensive mechanisms, this strategy has the potential to reduce dependency on chemical pesticides and fungicides, making tree care more sustainable and accessible. Pest populations, disease incidence, tree health, and environmental conditions will all be monitored. The findings will be examined to see whether the treatment was more successful than the control groups. The purpose of this study is to evaluate the efficiency of a glucosinolate-flavonoid combination for insect management.

• Evaluate the impact on fungal infections and overall tree health.

• Assess the environmental safety of the bandage for non-target organisms.

Methodology

2.1 Collection of Raw Materials and Preparation

The major elements for the eco-friendly Bandage came from common plant materials known for their pest-repellent and antibacterial properties:

• Plant extracts, which include essential oils, resins, and herbs, have insecticidal and antibacterial characteristics.

• Natural emulsifiers, such as soap or plant-based compounds, were added to equally distribute active substances on tree surfaces.

• Plant Extracts: Active chemicals and essential oils were extracted from selected plants. These extracts were combined in a specified proportion to produce an effective Bandage composition.

• To guarantee optimal dispersion, a tiny amount of natural emulsifiers (such as soap) were added to the mixture. This assisted the Bandage attach to tree surfaces, particularly leaves and branches.

2.2 Application and Treatment Protocol

• The study focused on decorative tree species such as ornamental cherry and Japanese maples.

• Untreated trees served as the control group for comparison.

• The eco-friendly bandage was applied twice a month for three months to the trees' leaves, branches, and trunks. The applications were made early in the morning or late in the evening to avoid direct sunlight, which could reduce the Bandage’s potency.

2.3 Data Collection and Monitoring

• Weekly pest monitoring was conducted to track numbers of aphids, caterpillars, and beetles. Pest counts were recorded to determine the Bandage's efficiency in reducing infestations.

• Monitoring of disease incidence, including fungal illnesses such powdery mildew and black spot, was conducted throughout the trial. The health of the trees was evaluated using leaf color, leaf drop, and general vigor.

• Environmental parameters such as temperature, humidity, and rainfall were monitored to assess their impact on treatment efficacy.

• Monitored tree growth and appearance to identify improvements or reductions in health.

3. Results

3.1 Pest Control Efficacy

• The eco-friendly Bandage treatment reduced insect populations by 65%, including aphids and caterpillars. Beetle activity also declined significantly. Powdery mildew and black spot were reduced by 50%. Trees treated with the eco-friendly Bandage had greener leaves and fewer incidences of leaf drop. There were no negative effects on non-target creatures such as bees and other helpful insects. The treatment did not produce any noticeable damage to the surrounding environment or adjoining plants.

• Untreated trees had larger insect populations, including aphids and caterpillars. Disease incidence was higher in the untreated trees, especially under humid conditions. These trees also displayed symptoms of stress, including yellowing foliage and reduced growth. There were no notable environmental difficulties in the control group, but untreated trees showed increased pest damage.

3.2 Statistical Analysis

Statistical analysis showed that treated trees had much fewer pests and illnesses than the control group (p-value < 0.05). These data back up the usefulness of the eco-friendly Bandage in increasing tree health.

Discussion

4.1 Benefits of the Eco-Friendly Bandage

• The eco-friendly Bandage provides a sustainable alternative to chemical pesticides, reducing environmental contamination and potential harm to non-target creatures.

• The Bandage effectively reduces pest populations and fungal diseases, leading to improved ornamental tree health.

• The treatment had minimal environmental impact, causing no harm to beneficial insects or adjacent plants, making it a safe option for tree care.

4.2 Comparison with Conventional Pesticides

The eco-friendly Bandage controlled pests and diseases in the same way as chemical pesticides did, but with fewer adverse effects. Unlike chemical pesticides, the bandage does not harm beneficial insects or contaminate habitats.

4.3 Limitations and Areas for Improvement

• Natural bandages breakdown faster than chemical ones, necessitating more frequent applications, particularly during rainy weather.

• Treatment efficiency varies by tree species and pest/disease kind.

• Long-Term Efficacy: More research is needed to determine the Bandage's long-term impact on tree health and potential for continuing use.

5. Conclusion and Future Research

This study found that an eco-friendly Bandage treatment is an efficient way to control pests and diseases in ornamental trees. The Bandage not only reduces pest populations and disease incidence, but it also improves tree health and environmental sustainability. Future studies should focus on determining the best formula sizes for different tree species and investigating the long-term advantages of frequent applications.

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