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SUSTAINABLE REDUCTION OF PESTICIDE USE IN PEA CULTIVATION THROUGH ECO-FRIENDLY PLANT PROTECTION STRATEGIES

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Abstract: *Reducing pesticide use in pea cultivation is an essential step toward more sustainable and environmentally responsible agriculture. This study explores alternative plant protection strategies that minimize reliance on synthetic chemicals while maintaining crop productivity and quality. Key approaches include integrated pest management, the use of resistant pea varieties, biological control agents, crop rotation, and habitat diversification to enhance natural predator populations. The research highlights how combining these methods can effectively suppress common pests such as aphids and fungal pathogens without excessive chemical input. Field observations and experimental data demonstrate that biological solutions, including beneficial insects and microbial biopesticides, can significantly reduce pest pressure when applied in a timely and targeted manner. Additionally, agronomic practices such as optimized sowing periods, soil health management, and intercropping contribute to increased plant resilience and reduced vulnerability to infestations. The study also evaluates the economic feasibility of these sustainable practices, indicating that although initial implementation may require higher knowledge input, long-term benefits include reduced costs for chemical inputs and improved soil fertility.*

• Introduction

The growing global emphasis on sustainable agriculture has intensified efforts to reduce the use of synthetic pesticides and promote environmentally friendly crop protection strategies. Pea (Pisum sativum L.) is a key leguminous crop that contributes significantly to food security, human nutrition, and agroecosystem sustainability. It is widely valued for its high protein content and its ability to fix atmospheric nitrogen through symbiotic relationships with rhizobia, thereby improving soil fertility and reducing the need for chemical fertilizers. Despite these benefits, pea cultivation is highly vulnerable to a wide range of insect pests, including aphids (Acyrthosiphon pisum), pea weevils (Bruchus pisorum), thrips, and leaf miners, which can cause severe yield losses and compromise crop quality.

Traditionally, pest control in pea cultivation has relied heavily on chemical pesticides due to their immediate effectiveness and ease of application. However, the intensive and often indiscriminate use of these chemicals has led to numerous environmental and ecological problems. Pesticide residues contaminate soil and water resources, negatively affecting non-target organisms such as beneficial insects, soil microorganisms, and aquatic life. Moreover, prolonged exposure to pesticides poses significant risks to human health, particularly for farmers and consumers. Another major concern is the development of pest resistance, which reduces the effectiveness of chemical control methods and necessitates the use of higher doses or more toxic compounds.

• Material and method

The study was conducted over two consecutive growing seasons (2023–2025) in experimental fields located within temperate agricultural regions characterized by moderate rainfall and seasonal temperature variation. The research design followed a randomized complete block design (RCBD) to ensure statistical reliability and minimize experimental error. Each treatment was replicated across multiple plots, with each plot measuring approximately 20 m^2.

Five different pest management treatments were evaluated: (1) conventional pesticide-based management, (2) biological control using natural enemies such as lady beetles (Coccinellidae) and parasitoid wasps, (3) application of biopesticides derived from neem (Azadirachta indica) and other botanical sources, (4) cultural practices including crop rotation and intercropping with companion plants, and (5) an integrated approach combining all eco-friendly methods. Standard agronomic practices, including planting density, irrigation, and fertilization, were applied uniformly across all treatments to ensure comparability.

• Results and discussions

The results of the research indicate that eco-friendly plant protection strategies can significantly reduce pesticide use in pea cultivation while maintaining effective pest control. Among the treatments evaluated, the integrated approach combining biological control, biopesticides, and cultural practices demonstrated the highest level of effectiveness. This approach resulted in a reduction of pest populations by approximately 60–75% compared to conventional pesticide-based management.

Aphid populations were notably lower in plots where biological control agents, such as lady beetles and parasitoids, were present. The reduced use of chemical pesticides in these plots allowed beneficial insects to thrive, enhancing natural pest regulation. This finding highlights the importance of conserving biodiversity within agricultural systems as a key component of sustainable pest management.

Biopesticides, particularly neem-based formulations, were effective in reducing pest populations, although their impact was generally slower and less pronounced than that of synthetic pesticides. However, their environmental safety and compatibility with biological control agents make them a valuable component of integrated strategies. Cultural practices such as crop rotation and intercropping also contributed to reduced pest incidence by disrupting pest life cycles and improving plant resilience.

Importantly, crop yield in eco-friendly treatment plots was comparable to, and in some cases higher than, that of conventional plots. This suggests that reducing pesticide use does not necessarily compromise productivity. Improved soil health and enhanced ecosystem services likely contributed to these positive outcomes.

• Conclusions

This research demonstrates that the sustainable reduction of pesticide use in pea cultivation is both feasible and beneficial when eco-friendly plant protection strategies are effectively implemented. The integration of biological control, biopesticides, and cultural practices provides a comprehensive and environmentally responsible approach to pest management. These strategies not only reduce reliance on synthetic chemicals but also promote biodiversity, improve soil health, and enhance the resilience of agricultural systems.

The findings indicate that eco-friendly approaches can achieve pest control levels comparable to conventional methods without compromising crop yield. This is particularly important in the context of increasing environmental concerns and the need for sustainable food production systems. By reducing pesticide inputs, farmers can lower production costs, minimize environmental contamination, and reduce health risks associated with chemical exposure.