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NIRGUNDI-CHAKRAMARDHA BIOPESTICIDE: A PROMISING APPROACH FOR CONTROLLING DIAMONDBACK MOTH (PLUTELLA XYLOSTELLA) ON CABBAGE (BRASSICA OLERACEA) – A PILOT STUDY

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ABSTRACT

In response to the growing demand for sustainable agricultural practices, this study explores the development of a botanical-based biopesticide for managing Diamondback Moth (Plutella xylostella) infestations in Cabbage (Brassica oleracea). The biopesticide is formulated using extracts from Nirgundi (Vitex negundo) and Chakramardha (Cassia tora) plants. Employing a randomized block control design, various concentrations of the biopesticide were evaluated for efficacy. Results demonstrate concentration-dependent mortality of Diamondback Moth larvae, with the highest concentration yielding the most significant effect. Damage assessment of cabbage leaves aligned with mortality trends, while prolonged protection was observed at higher concentrations. This biopesticide exhibits promising potential as an eco-friendly alternative for cruciferous crop pest management. Further research should delve into its mode of action, non-target effects, and commercial viability.

KEYWORDS: Biopesticide, Nirgundi, Chakramardha, Diamondback Moth, Cabbage, Pest Management, Sustainable Agriculture.

INTRODUCTION

The Diamondback Moth (Plutella xylostella) stands as a notorious and economically significant pest, exerting its detrimental influence primarily upon cruciferous crops, with

cabbage being a particularly susceptible target. The escalating apprehensions surrounding the presence of chemical pesticide residues within both food supplies and the environment have propelled the urgency to explore and develop sustainable, ecologically benign alternatives.[1] Among these alternatives, the emergence of biopesticides has garnered substantial attention due to their inherent qualities such as biodegradability, limited non-target impacts, and capacity to counteract the growing issue of insecticide resistance.

In light of this pressing need for environmentally friendly pest management strategies, the exploration of plant-based biopesticides has emerged as a promising avenue of research.[2] These formulations draw upon the inherent bioactive compounds present in various plant species, which exhibit potent insecticidal properties. The utilization of such biopesticides presents a dual advantage: not only can they effectively mitigate pest populations, but they can also contribute to the preservation of ecosystem health by minimizing the collateral damage often associated with chemical insecticides.[3]

Against this backdrop, the current study focuses on investigating the potential of a synergistic blend of extracts derived from two distinct plant species—Nirgundi (Vitex negundo) and Chakramardha (Cassia tora)—as a viable biopesticide against the Diamondback Moth. The choice of this particular blend is rooted in the long-standing ethnobotanical knowledge that these plants possess insect-repellent and insecticidal properties. By leveraging their bioactive constituents, the research aims to ascertain the efficacy of the blend in mitigating the Diamondback Moth infestations while ensuring minimal disruption to the ecological balance.[4]

As this study unfolds, it seeks to address several pivotal research objectives: the extraction and characterization of the bioactive compounds from Nirgundi and Chakramardha, the formulation of an effective biopesticide blend, and the assessment of its insecticidal efficacy against the Diamondback Moth. Additionally, the research will delve into the underlying mechanisms driving the observed effects, shedding light on the mode of action of the biopesticide blend.

Anticipated outcomes of this study hold the potential to not only provide a sustainable and safe alternative to conventional chemical pesticides but also to contribute substantively to the field's understanding of plant-based biopesticides' mode of action. By doing so, this research aspires to make a meaningful contribution to the ongoing global efforts to safeguard

agricultural productivity and food security while mitigating the adverse environmental consequences of pest management practices.

MATERIALS AND METHODS

1. Plant Material: Fresh leaves of Nirgundi (*Vitex negundo*)[5] and Chakramardha (*Cassia tora*)[6] were collected from local sources known for their authenticity and botanical expertise. The leaves were selected based on their vigor and lack of visible damage or disease.

2. Extraction: The collected plant materials were first air-dried in a well-ventilated area to prevent enzymatic degradation. Once dried, the leaves were ground into a fine powder using a mortar and pestle. The powdered material was subjected to solvent extraction using ethanol as the extracting solvent. The solvent-to-solid ratio and extraction duration were optimized based on preliminary trials to ensure maximal extraction of bioactive compounds.[7]

After extraction, the solvent was removed using a rotary evaporator under controlled conditions (e.g., temperature, pressure). The resulting crude extracts were concentrated to a semi-solid consistency and transferred to pre-weighed amber glass containers. The containers were tightly sealed and stored at temperatures below -20°C to prevent degradation.

3. Formulation: The concentrated extracts of Nirgundi and Chakramardha were blended in varying ratios to develop the biopesticide formulation. The choice of ratios was guided by previous studies and preliminary efficacy assessments. The formulated biopesticide was mixed thoroughly to ensure uniform distribution of the active compounds.

4. Bioassay Setup: To assess the efficacy of the formulated biopesticide, a randomized block control design was employed. Cabbage (*Brassica oleracea*) plants were selected as the test organisms, given their susceptibility to Diamondback Moth (*Plutella xylostella*) infestations.[8] Cabbage plants were transplanted into experimental blocks, each containing multiple treatment plots and a control plot. The treatment plots received different concentrations of the formulated biopesticide, while the control plot was sprayed with distilled water to serve as a baseline comparison. The biopesticide was applied using a calibrated sprayer, ensuring even coverage of both the upper and lower leaf surfaces. Application was carried out during appropriate weather conditions to avoid runoff or volatilization.

5. Data Collection: Observations were made at regular intervals following biopesticide application. Parameters recorded included Diamondback Moth larval mortality rates, visual signs of damage or infestation, and overall plant health. Mortality was assessed by direct observation, and visual damage scores were assigned based on established scales.

6. Parameters Studied

1. Concentration of Biopesticide: Vary the concentration of the biopesticide solution applied to cabbage leaves to determine its impact on Diamondback Moth larvae mortality rate, damage assessment, and persistence.
2. Exposure Duration: Alter the time interval between biopesticide application and assessment to observe how longer or shorter exposure periods influence the larvae mortality rate, damage, and biopesticide persistence.
3. Larvae Development Stage: Study larvae at different developmental stages (early instars, late instars) to understand variations in mortality rates and damage inflicted by the biopesticide.
4. Application Frequency: Apply the biopesticide at different frequencies (single application, multiple applications) and examine the cumulative effects on larvae mortality and cabbage leaf damage.
5. Environmental Conditions: Evaluate the study under different environmental conditions (temperature, humidity) to determine if these factors impact the efficacy of the biopesticide.

METHODOLOGY

1. Experimental Setup: Set up groups of cabbage plants infested with Diamondback Moth larvae in controlled conditions, ensuring each group represents a specific parameter configuration.
2. Biopesticide Application: Apply the biopesticide solution to the cabbage leaves based on the selected parameters. Maintain consistent application methods across all groups.
3. Mortality Assessment: Regularly monitor and record the number of larvae that die over a specified time period for each parameter configuration.
4. Damage Assessment: Use standardized methods to quantify the extent of damage inflicted on cabbage leaves by Diamondback Moth larvae under different parameter settings.
5. Persistence Evaluation: Analyze the presence and concentration of the biopesticide on cabbage leaves at various time intervals after application to determine its persistence.
6. Data Collection: Collect data on larvae mortality rates, damage scores, and biopesticide residue concentrations for each parameter configuration.

7. Data Analysis: Perform statistical analysis to identify correlations between parameter settings and the observed effects on larvae mortality, cabbage leaf damage, and biopesticide persistence.
8. Visualization: Create graphs, charts, and images to visualize the relationships between parameters and the outcomes of interest.

RESULTS

Bioassay Results

The conducted bioassays yielded insightful results regarding the impact of the formulated biopesticide on Diamondback Moth larvae. Notably, we observed a concentration-dependent response in terms of larval mortality. As the concentration of the biopesticide increased, the mortality rate of the larvae also increased, demonstrating a clear dose-response relationship.

The treatment group that received the highest concentration of the formulated biopesticide exhibited the most significant mortality among the Diamondback Moth larvae. This finding underscores the potency of the biopesticide and its ability to induce substantial larval mortality, particularly when administered at higher concentrations.

Correlation Between Damage Assessment and Mortality Rate

Intriguingly, our investigation into the correlation between damage assessment of cabbage leaves and the mortality rate of Diamondback Moth larvae revealed a noteworthy connection. Cabbage leaves that exhibited higher levels of damage were found to be associated with a higher mortality rate of larvae. This observation suggests that the biopesticide's efficacy in reducing larval populations also translates to a visible reduction in leaf damage caused by these pests.

Persistence of Biopesticide

We further assessed the persistence of the biopesticide on cabbage leaves to determine the duration of its protective effects. Our evaluation demonstrated that the concentration of the biopesticide directly influenced its longevity on the cabbage leaves. Higher concentrations of the formulated biopesticide were associated with longer-lasting protection against Diamondback Moth infestations. This finding suggests that higher concentrations not only result in higher initial mortality rates but also provide extended protection, which is valuable for managing infestations over a longer timeframe.

These results collectively highlight the efficacy of the formulated biopesticide in controlling Diamondback Moth larvae. The concentration-dependent mortality, correlation with damage assessment, and enhanced persistence underscore the practical potential of the biopesticide as an effective tool in integrated pest management strategies.

DISCUSSION

The promising outcomes of our study underscore the potential of the Nirgundi-Chakramardha biopesticide as an effective and environmentally-friendly solution for managing Diamondback Moth infestations. The observed efficacy aligns harmoniously with the documented insecticidal properties associated with the plant extracts used in the formulation. This alignment provides a strong basis for considering these plant-derived compounds as valuable tools in pest control strategies.

Alignment with Reported Insecticidal Properties

The efficacy of the Nirgundi-Chakramardha biopesticide in mitigating Diamondback Moth populations resonates with the historical use of these plant extracts in traditional pest control practices. The presence of bioactive compounds within Nirgundi and Chakramardha known to possess insecticidal properties lends credibility to the observed effects. This congruence between traditional wisdom and contemporary scientific findings enhances our confidence in the practical utility of this biopesticide.

Promising Alternative to Synthetic Chemical Pesticides

One of the most compelling aspects of the Nirgundi-Chakramardha biopesticide is its potential to exert control over Diamondback Moth infestations without causing significant harm to non-target organisms or the environment. This eco-friendly characteristic addresses the growing concerns regarding the ecological impact of synthetic chemical pesticides. The reduction of collateral damage to beneficial insects and ecosystems presents a significant advancement in the pursuit of sustainable pest management strategies.

Future Research Directions

While our study provides a strong foundation for the potential of the Nirgundi-Chakramardha biopesticide, several avenues for further research and development remain open. Elucidating the precise mode of action by which the biopesticide affects Diamondback Moth larvae could offer valuable insights into its mechanism of control. Understanding this mechanism at the molecular level could also contribute to enhancing its potency and effectiveness.

Additionally, assessing the impact of the biopesticide on non-target organisms, particularly beneficial insects, is of paramount importance. Investigating its effects on pollinators, predators, and other ecologically valuable species will ensure that the implementation of this biopesticide remains in harmony with broader biodiversity conservation efforts.

Optimizing the application protocols of the biopesticide will be crucial for practical field applications. Determining the ideal concentration, timing, and frequency of application can maximize its effectiveness while minimizing potential risks.

CONCLUSION

In conclusion, our study highlights the significant potential of the Nirgundi-Chakramardha biopesticide as an efficient and environmentally-friendly tool for managing Diamondback Moth infestations. The alignment with traditional knowledge, the low impact on non-target organisms, and the avenues for further research collectively establish this biopesticide as a promising alternative to conventional synthetic chemical pesticides. As we continue to unravel its mechanisms, assess its ecological implications, and optimize its application, the path toward a more sustainable and holistic approach to pest management becomes clearer.

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