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Enhancing Urban Chili Production: Biopesticide Use and Cultivation Assistance

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ABSTRACT

This study aims to enhance the productivity of large chili cultivation in urban areas through cultivation assistance and pest control using biopesticides. The methods employed include surveys to assess initial conditions, hands-on assistance for proper cultivation techniques, and the application of biopesticides to manage aphid infestations. The results revealed a significant improvement in the growth and production of chili plants. Farmers, previously struggling with severe aphid infestations, successfully harvested three times during the program, with yields increasing by 30% in the second harvest and 50% in the third. Effective pest control using biopesticides played a crucial role in reducing aphid populations while promoting healthier plant growth. Additionally, cultivation techniques adapted to urban conditions, such as using disease-resistant varieties and smart agricultural technology, significantly contributed to better outcomes. This approach minimizes chemical pesticide dependency, supports environmental sustainability, and improves chili quality. The findings emphasize the importance of integrating environmentally friendly methods and technology to strengthen urban agricultural systems and enhance crop productivity.

INTRODUCTION

Aphids (*Aphis spp.*) and mealybugs (*Phenacoccus manihoti*) are significant challenges in chili pepper cultivation, particularly in urban environments with limited land. Aphids damage plants by sucking sap from leaf tissues, leading to yellowing leaves, stunted growth, and a decline in photosynthetic capacity. They are also vectors for viral diseases, such as chili mosaic virus, which can drastically reduce yields and threaten production sustainability (Khan et al., 2020; Garza et al., 2016).

Urban cultivation intensifies these challenges. Limited land leads to monocropping and prevents crop rotation, increasing vulnerability to pest attacks. The reliance on chemical pesticides exacerbates health risks and environmental degradation, including soil and water quality decline (Ali et al., 2022). This situation highlights the urgent need for sustainable pest control methods tailored for urban farming.

Combining biopesticides with smart agricultural technologies offers a novel and efficient approach to aphid management. Biopesticides provide environmentally friendly pest control, reducing the dependence on chemicals, while IoT-based sensors can monitor plant health and detect pest activity early, enabling timely interventions (Bourzac, 2021). The integration of these methods enhances chili productivity and aligns with sustainable urban agriculture practices.

Aphid infestations on chili plants can lead to varying degrees of damage based on the intensity of attacks, environmental conditions, and control measures. Severe infestations disrupt photosynthesis, reduce fruit formation, and impact fruit quality, with potential losses of 50–80% if left uncontrolled

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(Zhou et al., 2019; Dube et al., 2021). Beyond economic losses, prolonged infestations can also destabilize food security by affecting chili supply and market prices.

Effective solutions require a shift toward environmentally friendly, technology-based pest control methods. Assistance programs for urban farmers can facilitate the adoption of biopesticides and smart technologies, not only addressing aphid infestations but also reducing pesticide dependence and ensuring sustainable urban chili production (Kumar et al., 2021).

RESEARCH METHODS

This research employs a combined method approach that includes surveys, assistance with chili plant cultivation, and the use of biopesticides for pest control. Urban chili farmers facing aphid infestation problems can find practical solutions in this method.

1. Survey
   We conducted surveys to identify the initial conditions of chili pepper cultivation and the level of aphid infestation in several selected urban locations. This survey involved direct observations of chili pepper plants, land conditions, and the severity of aphid infestations. The data collected included the number of aphids found, the damage to plants caused by aphids, and factors influencing pest infestations, such as cultivation patterns, pesticide use, and the presence of natural aphid enemies. The survey also included interviews with farmers to understand the challenges faced in pest management and chili pepper cultivation.
2. Assistance in Chili Plant Cultivation
   We assist chili farmers by providing information on proper cultivation techniques to optimize yields and minimize pest attacks, particularly aphids. The techniques taught include the selection of disease-resistant chili seedlings, proper management of planting media, and the implementation of crop rotation systems to reduce pest accumulation. Additionally, farmers receive training on how to manage optimal humidity and temperature for the growth of chili plants on limited land.
3. Control of Aphid Disease Using Biopesticides
   As an alternative to the use of chemical pesticides, this research implements the use of biopesticides in controlling aphid infestations. The biopesticides used are based on natural microorganisms such as entomopathogenic fungi or the bacterium Bacillus thuringiensis, which can control aphid populations without harming the environment or human health. We trained farmers in the correct dosage and effective spraying methods for the use and application of biopesticides. We expect the use of biopesticides to lessen reliance on chemical pesticides while preserving the equilibrium of the agricultural ecosystem.

RESULTS AND DISCUSSION

After providing assistance in the cultivation of large chili plants at the partner location, the results obtained showed a significant increase in the growth and production of chili. We applied proper cultivation techniques, managed the growing media, and used biopesticides for pest control. The partner farmers reported that the chili plants, previously stunted by aphid attacks, are now exhibiting good and stable development after a few months of implementation (Setiawan et al., 2021).

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Figure 1. Disease Attack on Large Chili Plants

The image depicts the state of the chili plants prior to assistance, their growth stunted by an aphid infestation. The plants look weak, with yellowing and curling leaves due to the sap-sucking by aphids. This attack disrupts the photosynthesis process and affects the quality of the chili harvest (Ali et al., 2019).

Until now, the partner farmers have successfully harvested three times with increasing results in each harvest period. In the first harvest, the yield was still relatively low, but after the implementation of more optimal techniques and effective pest control, the chili production increased in the second and third harvests. In the second harvest, the yield increased by about 30% compared to the first harvest, while in the third harvest, the production increased more significantly by 50%. This shows that the techniques applied are starting to have a positive impact on the harvest results and the growth of the chili plants (Haryanto et al., 2020).

Figure 2. Growth and Production of Large Chili Plants

This image shows the condition of chili plants during the period after assistance, where the plants grow lush with green leaves and more abundant, high-quality chili fruits. The significant yield increase during the second and third harvests demonstrates the effectiveness of the assistance in enhancing plant condition and optimizing chili production (Sulistyo et al., 2022).

This success shows that assistance involving proper pest control with biopesticides and appropriate cultivation techniques can increase the yield of large chili peppers. The significant reduction in aphid pest attacks plays a major role in improving plant health and the quality of the harvest. One of the main factors contributing to the success of large chili cultivation at partner locations is the more effective management of aphid pests using biopesticides. Before the assistance, the aphid infestation was quite severe and hindered the growth of the chili plants. However, the

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application of biopesticides significantly controlled the aphid population, enabling the chili plants to grow healthier and more productively. The biopesticide used proved effective in reducing the damage caused by aphids without negatively impacting the environment, unlike chemical pesticides, which often harm ecosystems and human health (Sulaiman et al., 2021).

Figure 3. Spraying Using Biopesticide

This image shows the process of spraying biopesticide on chili plants. Regular application of biopesticides ensures optimal pest control. Smart agricultural technology, which involves the use of sensors and monitoring systems, also helps monitor plant conditions and the severity of pest attacks in real time, allowing for more efficient and timely application of biopesticides (Yusuf et al., 2023).

In addition to effective pest control, the application of cultivation techniques suitable for urban land conditions also plays an important role in improving the quality of chili plants. The use of disease-resistant chili varieties, effective management of growing media, and the utilization of smart agricultural technology are the main supporting factors in improving chili cultivation results in urban areas. Although urban environmental challenges such as land limitations and air pollution still exist, the implementation of smart agricultural systems with the help of technology and biopesticides has proven effective in supporting the success of chili cultivation in urban environments (Hadi et al., 2021).

However, despite the significant improvement in harvest yields, some challenges persist. These include the temperature inside the greenhouse, which can sometimes affect the quality of the harvest, and the poor air circulation within the greenhouse due to its proximity to buildings. Therefore, we expect to strengthen the sustainability of chili farming in urban areas by taking further steps to enhance plant resilience to environmental conditions (Rahmawati et al., 2022).

CONCLUSION

The mentoring of large chili plant cultivation in urban environments has proven effective in increasing productivity and reducing aphid infestations. The use of biopesticides in controlling aphids and whiteflies has shown positive results, with a significant decrease in pest attacks compared to before the mentoring. The application of proper cultivation techniques, such as selecting disease-resistant seeds and good land management, also supports the growth of healthy and productive chili plants. During the mentoring period, partner farmers successfully harvested large quantities of chili peppers three times, with the yield increasing each time. These better harvests demonstrate the success of implementing environmentally friendly pest control methods and cultivation techniques suitable for urban conditions. This assistance also contributes to reducing dependence on chemical pesticides, which can support the sustainability of agriculture in urban environments. Therefore, pest control approaches based on biopesticides and environmentally friendly cultivation techniques need to

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be continued and expanded to enhance urban agricultural resilience and chili plant productivity. Policymakers should consider providing incentives for urban farmers to adopt biopesticide-based pest control methods and offer training programs to scale up these practices across urban areas. Future research should focus on optimizing biopesticide formulations and exploring their long-term effects on urban agriculture resilience and productivity

CONFLICT OF INTEREST

The authors declares that there is no conflict of interest

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