Future Vision Pakistan
Vol: 1, Issue: 1
PP: 4-11
DOI: 10.5281/zenodo.7770190

Sustainable Management Techniques for Controlling Locust Swarms in Pakistan

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Abstract

This review aims to provide an overview of the management techniques utilized in Pakistan for controlling locust outbreaks, which have caused significant agricultural losses in the country. The review covers several methods, including chemical and biological control, cultural control, and modern technologies. Locust outbreaks have been a persistent threat to Pakistan's agriculture, and various management techniques have been employed over the years. Chemical control using insecticides is the most commonly used method but has drawbacks such as high cost, environmental pollution, and insecticide resistance development. Consequently, there has been a shift towards more sustainable and environmentally friendly control methods, such as biological control using natural enemies and cultural control through changes in land use and cropping patterns. Biopesticides derived from natural sources and biocontrol agents like parasitic wasps and birds have proven to be effective in controlling locusts while minimizing the negative impact on the environment. Cultural control methods, such as crop rotation and intercropping, reduce crop susceptibility to locust damage. Early detection and monitoring of locust swarms are crucial for effective control and prevention of crop damage. In conclusion, a combination of different management techniques can be employed for effective and sustainable control of locusts in Pakistan, requiring continued research and development of new control methods that are both effective and environmentally friendly to ensure long-term success.

Keywords: locust, control management, biological control, crop rotation

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Introduction

Beetles, a type of horned grasshoppers from the Acrididae family, are notorious for causing crop damage when their populations increase and they swarm to cover greater distances. These insects typically lay their eggs in sandy areas during wet conditions, and in the presence of more rain and vegetation, their numbers rapidly multiply (1). Ranging in size from 0.5 to 3 inches and weighing about 0.07 ounces, beetles can travel several kilometers each day and cover vast areas, resulting in social, economic, and environmental impacts on a global scale.

Insects consume vegetables and crops as their source of food. They undergo a developmental process that lacks certain elements. Despite this deficiency, they are able to survive for approximately two months and during this time, they reproduce and transmit their genes. Sexual maturity is achieved by the insect after around 14 days. The female desert grasshopper deposits her eggs in either damp or Soil that is about 10cm deep and predominantly comprised of sand (2). Female desert grasshoppers exhibit different egg-laying patterns: Gregarious females deposit 2-3 egg cases, with each containing approximately 60-80 eggs, while solitarious females lay eggs 3-4 times and each case contains about 100-160 eggs. The development of the eggs is influenced by various factors such as soil type, temperature, and moisture. Egg growth does not occur below a temperature of 15 degrees Celsius. At a temperature of 19 degrees Celsius, the hatching period takes approximately 70 days while at a higher temperature range of 32-35 degrees Celsius, it takes only 10-12 days (3).

To tackle the current desert locust outbreak, the government of Pakistan has collaborated with the Food and Agriculture Organization of the United Nations and nearby relief agencies to implement proactive measures. In February 2020, the government approved a National Action Plan consisting of three phases aimed at managing the locust threat. The plan includes measures for threat assessment, surveillance and control efforts, and the use of agricultural land according to cultivation dates [35]. The initial stage focuses on surveillance and management to contain the growth and intensity of locust populations while addressing human and environmental impacts. Climate data was gathered in high-risk regions to enhance the effectiveness of targeted control measures. As of April 26, 2020, 76.9% of Pakistan's territory had been surveyed, and 5.5% had been treated with pesticides (4).

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From July to December 2020, the second phase prioritized safeguarding crops through local and global networks for monitoring and controlling locusts. In addition to boosting the country's capacity for early warning and intervention, the government offered prompt assistance to farmers and livestock owners. The strengthening of the Food Security and Nutrition Information allowed the Ministry of National Food Security and Research to increase their ability to manage desert locusts (5).

Starting after December 2020, the third and final phase involves the allocation of $76.1 million to the Project Management Unit for the 2021 fiscal year to enhance their capacity for planning and implementing surveillance measures aimed at creating locust-free areas (4).

This review encompasses the management control strategies that Pakistan has implemented to curb the locust infestation.

Insecticide Use in Locust Control

The use of insecticides in controlling locusts mostly involved conventional synthetic insecticides, and factors like availability, cost-effectiveness, environmental compatibility, and safety influenced the selection of insecticides and timing of their application (6). Diflubenzuron, an IGR, was one of the widely used alternatives to traditional pesticides because it hinders arthropod molting while not affecting vertebrates (7,8). Most pesticides employed to control locusts comprised of ultra-low volume oil-based formulations that mandated specialized spray apparatus for their application (8).

Pest Management Plan for Desert Locust Control

To attain environmentally sustainable and enduring pest management, the government of Pakistan has established a National Integrated Pest Management Plan. One of the aims of this plan is to reduce or eliminate the risk of insecticide resistance, but locust epidemics occur infrequently enough to prevent this. The proposed strategy aims to enable efficient interventions, promote cost-effective locust control methods, and enforce environmentally friendly approaches while prioritizing the safety of pesticide managers and sprayers. The pesticides utilized for combating desert locusts in Pakistan do not fall under the categories of extremely hazardous or very dangerous chemicals. Moreover, the adoption of low-toxicity methods can mitigate the risk of human poisoning. Biopesticides have been utilized in Somalia to control swarming locust species;

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however, their effectiveness in outbreak scenarios has not been thoroughly evaluated. At present, the most effective strategy for managing the locust outbreak is timing intervention efforts during the gregarization phase, with an emphasis on early action. The proposed plan aims to implement a monitoring system that utilizes low-residue pesticides with increased accuracy to detect and monitor the outbreak, allowing for the timely identification of the onset of phase transition. The monitoring technologies must be capable of effectively tracking the activity of desert locusts over time, both during and between outbreaks, to facilitate effective intervention (9).

To establish an early intervention threshold in locust-prone environments, it is essential to consider the integration of multiple factors which may indicate onset of gregarization. The determination of early intervention thresholds is also influenced by climatic variables such as rainfall levels, wind speed, and direction. Pakistan can benefit from an analysis that discovered the cycle of locust swarming movement in Africa, and phase transformation anticipation can be utilized in Pakistan, particularly if coordinated with India. The identification of other spatiotemporal patterns of desert locust aggregation can aid in enhancing surveillance efforts to trigger early intervention. Incorporating such findings into surveillance measures in Pakistan can enable the establishment of the optimal timing for early intervention in the event of a desert locust outbreak (10,11).

Biological Control of Acridid Populations

To safeguard human health and preserve wildlife habitats, it is recommended to use environmentally sustainable solutions instead of harmful pesticides for locust control. Innovative biological pest control methods, such as the use of fungus and bacteria in combination with harmful plant species, have been successful. By preying on locust larvae and young adults, natural predators can diminish locust outbreaks by as much as 90%. Hence, it is of utmost importance to preserve these ecosystems and habitats, such as by cultivating late-maturing crops in conjunction with tropical forests. Additional effective measures for managing locust upsurges include utilizing a combination of locust-toxic and wild plants to achieve over 50% foliage coverage, together with animal feeding techniques. Transforming low-lying regions into aquaculture farms for fish and shrimp can also be a feasible method. Burning plants and lighting bonfires in the dark have also been identified as effective control methods. To limit plague outbreaks in high-risk areas, physical traps, optical and mechanical devices, and exact Bayesian prediction modeling can be employed.

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Moreover, specific light and sound wave lengths can be utilized to improve trapping efficiency by interacting with locusts' phototactic behavior through glutamate and dopamine neurophysiology. Remote sensing, based on habitat greenness, represents a more viable approach for predicting locust eruptions than conventional satellite and radar data. Nevertheless, these technologies are still in the developmental stage and in need of assistance from governments to become effective (12–16).

The potential for biological control in acridid population dynamics is often overlooked due to the emphasis on chemical control. Classical biological control is considered the most desirable control measure when an introduced agent is established and exerts sustained control over the pest. However, due to the indigenous nature of most locusts to their environment, classical biological control presents a difficult prospect. Despite this, there are still opportunities, particularly during the egg phase when it is susceptible to parasitoid predation. Another approach is the use of entomopathogens, such as fungi and microsporidia, as in-undative, inoculative, and classical biocontrol agents, with a particular focus on their pest-specificity. By exploiting the specificity of entomopathogens, it is possible to develop biological pesticides or mycopesticides that exert a lasting effect on pest populations and enhance the role of arthropod natural enemies in pest control. Most acridids are susceptible to pathogens, but they usually evade them by moving to new habitats. Hence, discovering methods to regulate pathogen populations could result in effective pest control with minimal environmental consequences. In conclusion, the examination of biological control methods for acridid populations, including classical biological control, pest-specific microorganisms, and entomopathogens, could provide a sustainable and effective alternative to chemical control (17).

The Importance of Proactive Strategies in Controlling Desert Locust Outbreaks

Countries like Pakistan, which were impacted by the recent desert locust outbreak, had to respond to the invasion of swarms in a reactive manner as they had no other option. A proactive approach could have been adopted by Pakistan and other countries affected by the recent desert locust outbreak while it was originating in Saudi Arabia's interior Rub al Khali. This could have helped in suppressing breeding and gregarious activity before the transboundary movement of locusts occurred. Coordinated international efforts are necessary for timely intervention during periods of

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locust recession and for the prevention of gregarious outbreaks. There is already a centralized coordination hub in place, as the Food and Agriculture Organization (FAO) is responsible for coordinating monitoring, control, some research and training, and aid agency contributions. Effective and timely intervention against the desert locust outbreak in Pakistan and other affected nations largely depends on their ability and willingness to share and utilize information on locust activity during the recession period (18,19).

Conclusion

In conclusion, locusts are a significant threat to crops, especially during swarming periods. The Pakistan government has taken proactive measures to combat the current desert locust outbreak, collaborating with the Food and Agriculture Organization (FAO) of the United Nations and aid agencies in the vicinity. The National Action Plan consists of three phases aimed at managing the locust threat, including threat assessment, surveillance and control efforts, and the use of agricultural land according to cultivation dates. Pakistan has developed a comprehensive National Integrated Pest Management Plan that aims to achieve ecologically sustainable and long-term pest control. The plan prioritizes the facilitation of effective interventions, the management of locust control economics, and the implementation of increasingly eco-friendly measures while ensuring the protection of pesticide managers and sprayers. Intervention timing, which involves early intervention during the gregarization phase, is currently the most promising and readily available approach. The anticipation of phase transformation could be useful in Pakistan, particularly when synchronized with India, to enhance the effectiveness of intervention timing. Further studies are needed to develop improved control measures based on the spatiotemporal characteristics of desert locusts.

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