Impact of Novel Insecticides in Mulberry Ecosystem and its Residual Effect on Silkworm Growth& Productivity

ABSTRACT

Growing silkworms for the purpose of producing silk is a very old method that dates back thousands of years. Because they are restricted to consuming mulberry leaves, the exploited species of mulberry silkworm, scientifically known as *Bombyx mori* L., is used to produce silk. Nevertheless, a number of environmental elements including the existence ofpests in the mulberry ecosystem which is kept under check by pesticides and they have a substantial impact on the growth and productivity of the mulberry silkworm. Insecticides have been specifically selected with appropriate dosages as a means of controlling all the pests in mulberry ecosystem. The administration of these pesticides raises concerns about possible negative impacts on the environment and non-target insects which includes the mulberry silkworm itself regardless of whether they efficiently manage pests.A balanced approach must be maintained between increasing productivity and reducing environmental effect when raising mulberry silkworms for the manufacture of silk. Insecticides are essential for controlling pests but because of their possible impacts on mulberry silkworms and the entire ecosystem, sustainable sericulture cultivation requires diligent preparation and coordinated techniques. Farmers may protect the mulberry silkworm's health and encourage sustainable silk production for future generations by carefully using appropriate insecticides and looking into alternative pest management techniques. This review addresses both the ecological and sericultural aspects of the impact of pesticides and their subsequent effects on mulberry silkworms growth and productivity.

Keywords: Insecticide, Pesticides, Residual effect, Silkworm growth, Silk Productivity, Silkworm health,

INTRODUCTION

The impact of insecticide application and its residual effect on silkworm is a critical area. Silkworms, *Bombyx mori* L.,(Lepidoptera: Bombycidae)particularly those of the species are economically significant due to their role in silk production [7]. The cultivation of silkworms involves careful management of their environment including protection from pests that can

devastate silk production. Insecticides are commonly used to control these pests but their application raises concerns about potential adverse effects on silkworm health and silk quality [4].Understanding the impact of insecticides on silkworm requires a comprehensive examination of several interconnected factors. Firstly, the types of pesticides need to be employed and their way of action are crucial& important [29]. Different classes of insecticides such as organophosphates, pyrethroids, neonicotinoids and microbial agents exhibit varying levels of toxicity and persistence in the environment. Each insecticide type may have different mechanisms of action that could affect silkworm physiology and development [6].

Secondly, the timing and method of insecticide application plays a significant role in determining its impact on silkworms. Application methods range from foliar sprays to systemic treatments each affecting insecticide residue precipitation differently in the sericulture ecosystem [1]. Residues can persist on mulberry leaves which is the primary food source for mulberry silkworm (*Bombyx mori* L.)and in the soil potentially exposing silkworm and mulberry ecosystem to insecticide residues. Moreover, the physiological responses of silkworms to insecticide exposure need thorough investigation. Studies have indicated that exposure to sublethal doses of insecticides can alter developmental stages, affect its feeding behavior and even reduce silk yield & quality [15]. The biochemical pathways and metabolic processes within the silkworm that may be disrupted by insecticides need to be elucidated to understand these impacts fully.Furthermore, the ecological implications of insecticide use in sericulture cannot be overlooked [30]. While insecticides are essential for pest control and their indiscriminate use can lead to ecological imbalance by affecting non-target and beneficial insects. This aspect necessitates a balanced approach to pest management that considers both economic viability and environmental safety concerns [13].

In addressing the complexities surrounding the impact of insecticide application on silkworm, collaborative efforts among the researchers, policymakers, farmers and industry stakeholders are essential [31]. Dialogue and knowledge-sharing platforms facilitate the exchange of best practices, innovations and experiences in sustainable pest management [27]. Embracing technological advancements in precision agriculture, digital monitoring and predictive modeling can further optimize insecticide use thereby minimize environmental footprints and enhance the resilience of sericultural systems against pest threats [21].

Looking ahead, proactive measures such as capacity building, training programs and extension services are pivotal in empowering farmers and stakeholders with the knowledge and tools needed to implement integrated pest management practices effectively [19]. Regulatory frameworks that prioritize safety, environmental stewardship and sustainable agricultural practices are indispensable in guiding responsible insecticide use and safeguarding the long-term viability of sericulture [17]. In conclusion, the impact of insecticide application and its residual effect on silkworms is a multifaceted issue that requires comprehensive research and informed management practices. By understanding the interactions between insecticides and silkworm at biochemical, physiological and ecological levels, we can develop strategies that minimize adverse effects while ensuring sustainable silk production [2]. This review aims to explore all the dimensions through a detailed analysis of current research and case studies offering insights into the complexities and challenges of managing pest control in sericulture.

ROLE OF INSECTICIDES IN MULBERRY CULTIVATION

The main purpose of raising mulberry silkworms is to produce silk, a very valuable natural material utilized in many industrial applications as well as in manufacturing textiles and garments. The sole food source for the silkworm larvae, mulberry (*Morus* sp.) are grown and its quality have significant impact on silkworm productivity [9]. To promote optimal growth and silk production, the leaves of these plants are gathered and fed to the silkworms in regulated conditions. However, mulberry plants are seriously damaged by insect pests which also have a major effect on mulberry silkworms [8]. Common pests that damage leaves extensively and have an adverse effect on silkworm larvae's health include caterpillars, mealy bugs, thrips, leaf webbers, beetles, aphids and mites. In India, farmers frequently opt for insecticides to control these pests [7].

IMPORTANCE OF MULBERRY PEST MANAGEMENT

Mulberry plants are susceptible to a range of pests that can significantly reduce leaf yield and quality. These pests include:

1. **Aphids:** Sap-sucking insects that weaken plants and can transmit viruses.
2. **Caterpillars:** Larvae of various moths and butterflies that feed on mulberry leavesand skeletonize them.

3. **Mealy bugs:** Suck leaf sap from tender leaves affecting nutritive value, plant height and leaf yield
4. **Thrips:**Desap the contents by sucking and causes streaks on epidermal portion of the leaf
5. **Leaf webber:** Webbing of tender leaves and feed on delicate tissues from inside considerably reducing leaf productivity.
6. **Whiteflies:**White spiraling patches on lower surface of the leaf and reduce its quality.
7. **Mites:** Tiny arachnids that cause stippling and discoloration of leaves.
8. **Leafhoppers:** Piercing-sucking insects that can cause leaf curling and yellowing.

Pest infestations can lead to defoliation, reduced photosynthesis and ultimately, decreased silk production. Effective pest management is therefore essential to mitigate these risks and maintain the health and productivity of mulberry plants [21].

ROLE OF INSECTICIDES IN MULBERRY PEST CONTROL

Insecticides are chemical substances specifically formulated to target and eliminate insect pests. They are a critical component of integrated pest management (IPM) strategies which aim to minimize pest damage while reducing environmental impact [11]. In mulberry cultivation, insecticides are primarily used to:

1. **Control Pest Populations:** Insecticides effectively reduce pest numbers preventing them from causing extensive damage to mulberry foliage.
2. **Protect Leaf Quality:** By controlling pests, insecticides help maintain the nutritional quality and quantity of mulberry leaves required for silk production.
3. **Ensure Yield Stability:** Consistent application of insecticides helps ensure stable leaf production which is crucial for meeting the demand of silkworms throughout their lifecycle.

TYPES OF INSECTICIDES COMMONLY EMPLOYED IN SERICULTURE

Insecticides used in mulberry cultivation can be categorized into several types based on their mode of action and chemical composition:

1. **Organophosphates:** These insecticides disrupt the nervous system of pests by inhibiting acetylcholinesterase, an enzyme crucial for nerve function.These are broad-spectrum insecticides which include Malathion and Diazinon.
2. **Pyrethroids:**These are synthetic insecticides that mimic the effects of natural pyrethrins which are derived from chrysanthemum flowers. They are known for their quick knockdown effect on insects. Examples include Permethrin, Cypermethrin, and Deltamethrin.
3. **Neonicotinoids:**Systemic insecticides that are absorbed by plants and move through their vascular system making them effective against a wide range of pests. These insecticides act on nicotinic acetylcholine receptors disrupting nerve function in pests. Imidacloprid and Clothianidin are examples commonly used in sericulture.
4. **Carbamates:** Similar to organophosphates, carbamates inhibit acetylcholinesterase affecting nerve impulse transmission in insects and they are broad-spectrum insecticides. Example Carbaryl.
5. **Biopesticides:** Derived from natural materials such as plants, bacteria or fungi, biopesticides offer a more environmentally friendly alternative to synthetic chemicals. Examples include *Bacillus thuringiensis* (Bt) and neem-based products.

Each type of insecticide has its mode of action, persistence in the environment and potential impact on non-target organisms which are critical considerations in evaluating their environmental consequences [3].

MODE OF ACTION OF INSECTICIDES

Insecticides exert their effects through various modes of action depending on their chemical properties:

1. **Contact Insecticides:** These insecticides kill pests upon direct contact with the insect's body surface. They often act quickly but may require thorough coverage of foliage.
2. **Systemic Insecticides:** Applied directly on plants surfaces or in soil, systemic insecticides are taken by the plant surfaces then into vascular tissues and transported through its system. They provide longer &lasting protection and are effective against pests that feed on plant sap [21].

EFFECTIVENESS AND APPLICATION CONSIDERATIONS

The effectiveness of insecticides in mulberry pest management depends on several factors:

1. **Timing:** Application timing is critical to target pests during vulnerable stages of their life cycle and prevent population outbreaks.
2. **Dosage:** Proper dosage ensures effective pest control while minimizing the risk of insecticide resistance and environmental contamination.
3. **Application Method:** Spray application is the most common method for insecticide application in mulberry cultivation. However, factors such as spray coverage, droplet size and weather conditions can influence efficacy [25].

IMPACT OF INSECTICIDES ON MULBERRY SILKWORM GROWTH & PRODUCTIVITY

Physiologically, silkworms exhibit varying degrees of susceptibility to different classes of insecticides with sublethal doses potentially disrupting developmental stages affecting feeding behavior and compromising silk quality & yield. These effects highlight the intricate biochemical pathways and metabolic processes within the silkworm that may be perturbed by insecticide exposure. Further research into the molecular mechanisms underlying these responses is essential for devising targeted interventions to mitigate negative impacts and optimize silk production efficiency [18].

From a biochemical perspective, understanding the persistence and degradation dynamics of insecticide residues in the silkworm's environment is crucial. Residues can accumulate in mulberry leaves and soil, leading to prolonged exposure and potential bioaccumulation in silkworms [16]. Monitoring and regulation of residue levels coupled with adherence to recommended application practices and withdrawal periods are essential to minimize the risk of contamination and ensure consumer safety in silk products [22].

Economically, the reliance on insecticides for pest control in sericulture is intertwined with the viability and competitiveness of silk production industries globally. Effective pest management strategies that integrate chemical and non-chemical approaches can enhance

productivity and profitability while reducing input costs and environmental impacts [5]. Investments in research and development of safer and more selective insecticides tailored to sericultural needs are critical for sustaining industry growth and meeting market demands for high-quality silk products [12,19].

While insecticides are effective against pests their use can have unintended consequences on mulberry silkworm:

1. **Acute Toxicity:** Direct exposure to insecticides can cause immediate toxicity in silkworms leading to reduced survival rates and developmental abnormalities.
2. **Sublethal Effects:** Even sublethal doses of insecticides can impair the growth and development of silkworms affecting their silk production capacity.
3. **Residual Effects:** Insecticides can persist on mulberry leaves after application leading to prolonged exposure for silkworms feeding on treated foliage [10].
4. **Impact on Silk Quality:** Chemical residues on mulberry leaves can contaminate silk fibers affecting the quality and market value of silk produced [24].

ENVIRONMENTAL CONCERNS

Despite their benefits in pest control, insecticides used in sericulture pose several environmental concerns:

1. **Impact on Non-Target Organisms:** Insecticides can harm beneficial insects such as pollinators (bees, butterflies) and natural predators (ladybugs, spiders) that play crucial roles in ecosystem balance and biodiversity [28].
2. **Water Contamination:** Runoff from agricultural fields treated with insecticides can carry these chemicals into nearby water bodies where they can accumulate and affect aquatic organisms. This contamination poses risks to fish, amphibians and other aquatic life forms [28].
3. **Residue Build-Up in Soil:** Continuous use of insecticides can lead to the accumulation of residues in the soil affecting soil health, microbial communities and nutrient cycling processes [10].

4. **Resistance Development:** Prolonged and intensive use of insecticides can lead to the development of resistance in pest populations necessitating higher doses or more potent chemicals which exacerbates environmental impacts [23].
5. **Human Health Concerns:** Exposure to insecticides through contaminated food, water or air can have adverse health effects on agricultural workers, nearby residents and consumers [20].

MITIGATION STRATEGIES

To minimize the impact of insecticides on mulberry silkworms and the environment, mitigation strategies commonly advised are:

1. **Biological Control**: Encouraging natural predators and parasitoids of pests can help reduce insecticide reliance [26].
2. **Cultural Practices:** Proper pruning, crop rotation and timing of pesticide applications can optimize pest control efficacy while minimizing environmental exposure.
3. **Alternative Pest Control:** Using pheromones, botanical extracts or microbial agents as alternatives to synthetic insecticides can reduce chemical inputs.
4. **Monitoring and Thresholds:** Regular monitoring of pest populations and implementing thresholds for insecticide application can prevent unnecessary treatments.
5. **Integrated Pest Management (IPM):** IPM emphasizes the use of multiple pest control methods including biological control (natural enemies), cultural practices (crop rotation), and chemical control (insecticides) as a last option. This approach minimizes reliance on insecticides and reduces environmental impacts [14].
6. **Reduced-Risk Insecticides**: Use insecticides that are less harmful to non-target organisms and have lower persistence in the environment. Regular monitoring and adjustment of insecticide application rates can help minimize environmental impacts.
7. **Buffer Zones and Best Management Practices:** Establish buffer zones around sericulture farms to reduce runoff into water bodies. Implement best management practices (BMPs) for insecticide application such as timing applications to minimize exposure to non-target organisms and reducing spray drift [28].

8. **Education and Training:** Educate farmers, agricultural workers and stakeholders about the environmental impacts of insecticides and promote practices that minimize these impacts.

CONCLUSION

In conclusion, the effects of insecticide treatment and their long-term effects on silkworms pose a difficult and various problems including ecological, physiological, biochemical and economic issues. Our investigation highlights the vital necessity for an holistic approach that guarantees efficient pest control while preserving the overall health and output of silkworm and advancing environmental sustainability. In terms of ecology, negligent utilization of pesticides presents considerable hazards to beneficial insects and non-target species, which could lead to the disruption of natural ecosystems and biodiversity. Adopting integrated pest management tactics that combine cultural practices, biological control techniques and cautious application of chemical insecticides is essential. These methods not only reduce negative effects on beneficial insects but also strengthen the sericulture ecosystem's with long-term stability and resilience.Furthermore, while the application of pesticides and their subsequent effects on silkworms creates considerable challenges and also offers opportunities for innovation and collaboration in the direction of sustainable sericulture practices. A harmonic balance between silk production, environmental stewardship and societal well-being can be achieved by promoting synergy between scientific research, technical improvements and stakeholder engagement. We can ensure that silkworms continue to flourish as important contributors to the global textile industry by paving the way for a robust and sustainable future for sericulture via coordinated efforts and shared responsibilities. With its rich cultural heritage and significant economic impact, sericulture needs to change to adopt more ecologically friendly methods in order to protect not just the quality of silk but also the wellbeing of ecosystems and communities around that ecosystem.

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