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NEW METHODS OF PROTECTING COTTON STALKS FROM PESTS IN AGRICULTURE

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Annotation;This scientific work is dedicated to an in-depth study of advanced and innovative methods for protecting cotton plants from pests in agriculture. The necessity of reducing over-reliance on traditional chemical pesticides and minimizing their negative environmental impacts, alongside the development of pest resistance, necessitates the creation of more sustainable and effective control strategies. This paper first analyzes the main pests that significantly damage cotton crops, outlining their biology and the economic harm they cause. Subsequently, modern approaches such as biological control methods, including the use of entomophagous and entomopathogenic agents, as well as monitoring and control tools like pheromone traps, are thoroughly examined. The importance of agrotechnical measures, including crop rotation, proper management of crop residues, and optimal planting dates, is highlighted. The advantages and future prospects of genetically modified cotton varieties resistant to pests, particularly Bt-cotton, are evaluated. Finally, the principles and practical significance of the **Integrated Pest Management (IPM)** system, which encompasses and effectively combines all these methods, are elaborated. The research findings emphasize the importance of comprehensive approaches for effectively protecting cotton crops from pests while increasing yields and maintaining ecological balance. These approaches serve to ensure sustainable agriculture not only for the present but also for future generations.

Keywords;Cotton pests,Cotton protection, Biological control, Entomophagous insects, Pheromone traps, Selective insecticides, Agrotechnical measures, Genetic modification, Bt-cotton, Integrated Pest Management (IPM), Sustainable agriculture, Ecological protection, Cotton farming, Cultivation,

Introduction

Cotton (Gossypium spp.) is a crucial strategic crop in Uzbekistan's agriculture, playing a vital role in the country's economy. The yield and quality of cotton depend directly on the effectiveness of protecting cotton plants from various pests that attack them. While the traditional use of chemical pesticides has been widespread, their negative impact on the environment, risks to human health, and the development of pest resistance have necessitated the search for new, sustainable, and ecologically friendly protection methods.

The increasing prevalence of these problems has heightened the need to develop and implement new protection methods for cotton cultivation that are sustainable, environmentally sound, and economically viable. This paper will comprehensively review modern approaches to protecting cotton plants from pests, including biological control, advanced agrotechnical measures, achievements in genetic engineering, and the potential of the Integrated Pest Management (IPM) system that combines them. The aim is to provide practical recommendations based on scientific advancements to increase cotton yields while ensuring ecological sustainability.

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Cotton Pests and Their Damage

Numerous pests attack cotton crops, causing significant economic damage at various stages of cotton plant development. In Uzbekistan, the most dangerous and widespread pests include:

1. **Cotton Bollworm (Helicoverpa armigera):** This is one of the most destructive pests of cotton, primarily damaging the bolls. The larvae penetrate the bolls, feeding on the lint and seeds, thus destroying the yield. Its ability to produce multiple generations, each highly prolific, makes it very challenging to control.
2. **Spider Mite (Tetranychus urticae):** These mites live on the underside of leaves and feed on plant sap. As a result, leaves turn yellow, curl, and drop, severely disrupting photosynthesis and drastically reducing yield. They multiply rapidly, especially in hot and dry climates.
3. **Aphids (Aphis gossypii):** Also known as cotton aphids, they suck sap from cotton leaves, shoots, and flowers, which slows down plant growth and causes leaves to curl. Aphids also secrete a sweet substance called "honeydew," which promotes the growth of sooty mold on leaves, further impairing photosynthesis.
4. **Pink Bollworm (Pectinophora gossypiella):** Another dangerous pest similar to the cotton bollworm that damages cotton bolls. Its larvae develop inside the bolls, damaging the cotton fibers and reducing the quality of the yield.
5. **Cotton Leafworm (Anomis flava):** Feeds on cotton leaves, which can be completely consumed, leading to the drying out of the plant.

Each of these pests has specific biological characteristics, requiring deep knowledge and a comprehensive approach for effective control. While traditional chemical methods provided short-term solutions, their long-term negative consequences have driven the need to implement new, sustainable protection methods.

1. Biological Control Methods

Biological control is a method based on controlling pests using their natural enemies (entomophagous and entomopathogenic agents). This approach significantly reduces or entirely eliminates the use of chemical preparations.

- **Utilization of Entomophagous and Entomopathogenic Agents:**

Entomophagous Insects: These are beneficial insects that prey on pests or parasitize them. For example, **Trichogramma** (Trichogramma spp.) parasitizes the eggs of cotton bollworms and other moths, preventing their development. In Uzbekistan, the practice of breeding Trichogramma in laboratories and releasing them into fields when pest populations increase is widely adopted. Similarly, **Bracon** (Bracon hebetor) is a natural enemy of cotton bollworm larvae and other destructive larvae. For controlling aphids and spider mites, predatory insects like **ladybugs** (family Coccinellidae) and **lacewings** (family Chrysopidae) are effective.

Entomopathogenic Agents: These are microorganisms that cause disease in pests, including bacteria, fungi, viruses, and nematodes. The most well-known example is the bacterium **Bacillus**

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thuringiensis (Bt). The toxins produced by Bt bacteria are lethal to the larvae of many moths, including the cotton bollworm and pink bollworm. When preparations containing spores of this bacterium are sprayed and ingested by pests, the toxins activate in their intestines, causing death. Additionally, entomopathogenic fungi such as **Beauveria bassiana** and **Metarhizium anisopliae** are also effectively used against various insects. They penetrate the insect's body, grow, and lead to its death. **Pheromone Traps:** Pheromones are chemical substances emitted by insects to attract conspecifics (usually males). **Pheromone traps** are used to monitor the flight dynamics of pests like cotton bollworm and pink bollworm and to reduce their populations. Synthetic pheromones in the traps attract male moths, trapping and eliminating them. This method also helps determine pest numbers and observe their development dynamics, which is crucial for determining the optimal timing for pesticide application, thereby optimizing pesticide consumption.

2. Agrotechnical Measures

Proper and timely agrotechnical practices create unfavorable conditions for pest development and naturally reduce their numbers. **Crop Rotation:** Continuously cultivating the same crop in a field for several years leads to the accumulation and proliferation of pests. Crop rotation in cotton fields, which involves planting other crops (e.g., legumes like alfalfa, mung beans, or cereals like wheat, corn) alternately with cotton, disrupts pest life cycles and eliminates their overwintering sites. **Management of Crop Residues:** After harvest, cotton stalks, leaves, and other plant residues left in the field can serve as overwintering and breeding grounds for many pests. Removing them from the field, burning them (if environmentally safe), or deep plowing helps eliminate these pest habitats. **Optimal Planting Dates and Rates:** Planting cotton at the right time and optimal dates ensures rapid and healthy plant growth. Strong and healthy plants are more resistant to pests. Also, adhering to planting rates – ensuring proper spacing between plants – promotes good ventilation in the field and prevents excessive moisture accumulation, which can limit the development of fungal diseases and some pests. **Weed Control:** Weeds can serve as an alternate food source and habitat for many agricultural pests. Regular weed elimination significantly reduces pest populations. **Optimizing Irrigation Regimes:** Proper irrigation regimens increase plant resistance to stress and create unfavorable conditions for certain pest types (e.g., spider mites).

3. Genetic Engineering and Resistant Varieties

Modern biotechnology, particularly genetic engineering, is offering revolutionary solutions for protecting cotton from pests. **Bt-cotton** (Bacillus thuringiensis cotton) is one of the most significant achievements in this field. **Bt-cotton:** This variety has been engineered with a gene (Bt gene) from the bacterium Bacillus thuringiensis, which causes the plant to produce a toxin when ingested by a pest (primarily the larvae of moths like cotton bollworm). This toxin activates in the pest's gut, leading to its death. Planting Bt-cotton significantly reduces the need for chemical insecticides, eases environmental pressure, and saves farmers' labor. At the same time, management strategies like creating "refugia" (areas of conventional cotton near Bt-cotton fields) are employed to prevent the development of resistance to Bt-cotton.

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4. Selective Insecticides and Minimal Chemical Impact

While new methods aim to reduce the need for chemical agents, it may not always be possible to eliminate them entirely. In such situations, the use of **selective insecticides** is crucial. **Selective Insecticides:** These preparations affect only specific pest species, causing minimal harm to beneficial insects (entomophagous agents) and the environment. They are preferred over broad-spectrum insecticides (which kill all insects). When chemical treatment is necessary, it is recommended to apply selective preparations only when the economic damage threshold is reached and in precisely localized areas. This is also known as "spot" treatment.

Integrated Pest Management (IPM)

While each of the new methods mentioned above can be effective individually, the best results are achieved by applying them collectively, within a comprehensive system known as **Integrated Pest Management (IPM)**. IPM is a holistic approach that involves the rational integration of all available control methods (agrotechnical, biological, chemical, mechanical) to keep pest populations at an economically acceptable level.

The main principles of IPM include:

1. **Continuous Monitoring and Forecasting:** Regularly observing pest population dynamics, determining their numbers, and forecasting their development. This is done through pheromone traps, observation plots, and laboratory analyses. This information allows for timely and precise implementation of pest control measures.
2. **Economic Threshold Level (ETL):** An economic damage threshold is determined for each pest species. Chemical or other costly control measures are only applied when pest numbers exceed this threshold. This prevents unnecessary treatments and reduces costs.
3. **Preventive Measures:** Agrotechnical measures aimed at preventing pest outbreaks (crop rotation, crop residue management, weed control) are prioritized.
4. **Priority of Biological Control:** Wherever possible, biological control agents (entomophagous and entomopathogenic agents) are preferred over chemical preparations. This is safer for beneficial insects and the environment.
5. **Use of Selective Chemical Agents:** When chemical treatment is necessary, only selective insecticides that specifically target the pest and cause minimal harm to beneficial insects are used.
6. **Farmer Education and Capacity Building:** Increasing the knowledge and skills of farmers and agronomists regarding IPM principles and new technologies is crucial.

The IPM system not only helps increase cotton yields and improve product quality but also plays a vital role in ensuring the ecological sustainability of agriculture. Through this system, soil fertility is preserved, biodiversity is protected, and water resources are used efficiently.

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Conclusion

Protecting cotton plants from pests remains one of the most important and pressing tasks in modern agriculture, as it directly impacts cotton yield, quality, and economic efficiency. As evidenced by this scientific work, relying solely on chemical agents is not sustainable in the long run and leads to ecological problems. Instead, implementing **Integrated Pest Management (IPM)** strategies can achieve significantly more effective and sustainable results.

New methods such as using biological control agents (entomophagous and entomopathogenic agents), monitoring and mass trapping with pheromone traps, proper application of agrotechnical measures (crop rotation, crop residue management, optimal planting dates), and cultivating genetically resistant cotton varieties (e.g., Bt-cotton) play a crucial role in managing pest populations. These approaches not only increase yields and improve product quality but also help preserve soil fertility, ensure efficient use of water resources, and protect biodiversity.

In the future, even greater achievements in protecting cotton crops from pests can be attained by supporting innovative technologies and scientific research. Specifically, research should actively focus on identifying new entomophagous species, enhancing the effectiveness of entomopathogens, mapping pest genetics and developing new genetic modifications against them, and applying smart agriculture technologies (drones, sensors, artificial intelligence) in pest control. This will, in turn, ensure the sustainable development of the entire agro-industrial complex, significantly reduce the ecological footprint of cotton production, increase farmers' incomes, and ensure the production of safe products for consumers.

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