



**ORGANIC FARMING AND MODERN TECHNIQUES IN INSECT PEST
CONTROL: A REVIEW**

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ABSTRACT

The review explores recent advancements in agricultural pest control and their role in achieving sustainable agriculture that reduces reliance on traditional chemical pesticides. It focuses on the concept of organic farming as a system that utilizes natural methods to maintain soil fertility, protect the environment, and produce safe food free from chemical pollutants. The research also reviewed a range of modern pest control technologies, including the use of pheromones to disrupt insect behavior, prevent reproduction and repellents that limit pest spread in agricultural fields. It further examines sterilization methods using radiation or chemicals to reduce insect reproduction, as well as feeding inhibitors that prevent insects from benefiting from the host plant. The research also discusses insect development inhibitors and growth regulators that interfere with the insect's vital processes and prevent the completion of its life cycle. It highlights the importance of integrated pest management (IPM), which combines biological, mechanical, and chemical methods in a balanced manner. Finally, it touches upon precision agriculture, which utilizes satellites and drones to monitor insect infestations and pinpoint their exact locations. The research concluded by emphasizing that integrating modern technologies with the principles of organic farming represents a promising trend for achieving food security and reducing environmental and health damage resulting from the excessive use of chemical pesticides.

Keywords: Agriculture, Farming, Integrated, management Pest,

INTRODUCTION

Organic farming is defined as a system of agricultural land management that places major restrictions on the use of chemical fertilizers and pesticides. It aims to produce food free of chemical residues, develop environmentally friendly production methods, and implement production techniques that restore and maintain soil fertility (Al-Taher, 2015). Organic farming is based on producing food naturally without the use of synthetic chemicals such as pesticides and manufactured fertilizers, while maintaining ecological balance. In organic farming, pest and insect control is achieved through biological control using natural enemies, the resistance of native plants to pests and insects, crop rotation, crop diversification, selecting appropriate planting times, using suitable tillage and cultivation methods, and using organic fertilizers with optimal irrigation management (Tammar, 2017). According to Nassar (2022), the principles of organic farming include the following:

- (i) Soil, plant, animal, and human health: The health of the ecosystem is interconnected, as any imbalance in the soil or water will affect food quality and consumer health.



- (ii) Ecological balance: This is achieved by encouraging biodiversity on the farm through the cultivation of multiple crops and the use of plants that repel or attract beneficial insects.
- (iii) Reliance on local resources such as organic fertilizer, compost, and plant and animal waste.
- (iv) Prevention of chemical pollution by avoiding pesticides and synthetic fertilizers.

MODERN TECHNOLOGIES FOR INSECT CONTROL

Using Behavioral Control (Pheromones) in Pest Control

This refers to the use of chemicals that attract insects to a specific location, leading to their destruction, or causing disruption to their sexual activity, such as one sex separating from the other during mating, or disrupting their natural migration patterns.

Male insects are guided to females of the same species by a specific scent secreted by the females from specialized glands, known as pheromones or exogenous hormones. The discovery of this natural phenomenon led entomologists to recognize its potential for use in pest control. The pheromone structures of some important pests were determined, and these have now been synthesized in reasonable quantities with the help of chemists (Suchithra *et al.*, 2025).

Mass trapping of male insects

This means capturing as many males as possible by placing pheromone in small capsules in a trap equipped with a device to kill as many males as possible. This method is used to control the cotton leafworm by placing sex traps in cotton fields, 2 to 3 traps per acre, to catch the male insects (Suchithra *et al.*, 2025).

Pheromone spraying

Special pheromone preparations are sprayed on plants in the field, causing the males to be unable to find the females, as the female scent permeates the entire field. This method is called the "Confusion Technique." The following are examples of some sex pheromones used:

- a) Hexalure: A compound effective in attracting male pink bollworms in the field.
- b) Prodenialure: A compound effective in attracting male cotton leafworms.
- c) Siglure: A compound effective in attracting male fruit flies. (Hellmann *et al.*, 2024)

Agricultural Pest Repellents

These are natural chemical substances that have the ability to repel pests. Their role is secondary and limited in integrated pest management programs, as some of them, in their pure form, are no less dangerous to human health and the environment than some pesticides. Examples of insect repellents include:



- i) Bordeaux mixture, composed of copper sulfate, slaked lime, and water in a ratio of 6:10:100 respectively, when sprayed on vegetation, has a repellent effect on leafhoppers.
- ii) (6-methoxybenzoxazolinone): a substance responsible for the resistance of some corn varieties to the European corn stem borer.
- iii) Cresson: sprayed as a strip on the ground to act as a barrier against crawling insects, such as grain and storage pests, from infested areas to the collection and storage areas of the new crop.
- iv) Phenolic pentachloride and its sodium salt: ant repellents, which is why they are painted on the wood of telephone poles to protect them from ant infestation. (Neranjana *et al.*, 2021)

Autocidal Control (Sterile Insect Technique, SIT)

This refers to the methods used to eliminate the insect itself, or in other words, the pest's ability to destroy its own kind. This is done by insect sterilization, either by using radiation-induced sterilization or by using chemosterilants. This technique is used in insect pest control (Nath *et al.*, 2025).

Radiation-induced sterilization

In this process, insects are exposed to appropriate doses of gamma rays that are capable of penetrating the insect's body (due to their high energy) and causing a mutagenic effect as a result of chemical changes to the DNA within the chromosomes. Ultimately, this leads to sterility in the insects without affecting their lifespan. The late pupal stage and the beginning of the adult stage are considered the most suitable time for sterilizing insects, as the structure of the adult insect's body is almost complete. In this case, the division of somatic cells is very slow, while the division of germ cells is rapid. Then the effect of radiation on germ cells occurs, and thus the sterilizing effect takes place. The radiation sterilization method is summarized in rearing large numbers of males in the laboratory, where they are exposed to an appropriate dose of radiation, and then they are released into the fields, where these sterile males compete with normal males in mating with females, which leads to a reduction in the insect population of this pest. This technique of rearing, sterilizing, and then releasing males is called the "autocidal method" or "autosterilization," where the insects kill themselves (Abdihamidova *et al.*, 2025).

Chemosterilants

Chemical sterilizers are chemical substances that reduce or stop the reproductive capacity of an organism. These compounds may act as sterilizers for males only, females only, or both. The effect of chemical sterilizers may be permanent or temporary, and their effects may appear immediately or sometime after treatment. Chemical sterilizers differ from radiation in the following ways:

- i. Chemical sterilizers are less expensive than radiation sterilization, which requires complex and costly equipment.



- ii. They are easy to use and generally do not affect mating competition, while radiation often reduces mating competition among treated insects and has a harmful effect on their cells, which may lead to the insect's death or shorten its lifespan.
- iii. With chemical sterilizers, the sterilization process can be carried out in the original environment, while radiation sterilization requires raising large numbers of insects and releasing them after exposure to radiation, which is economically costly. (Kainat *et al.*, 2025).

Antifeedants

These are chemical substances that prevent an insect from initiating or continuing to feed on a suitable host. It doesn't matter whether these substances have a repellent or toxic effect. Feeding inhibitors are a modern approach to pest control and differ from insecticides in that they don't directly kill or repel the pest. Instead, their effect stems from their ability to prevent the pest from feeding, causing it to starve to death if it can't find another host (Pavela *et al.*, 2025). An example of a feeding inhibitor is the use of neem tree extracts (*Azadirachta inermis*). The benefits of using neem include the following (Morakchi *et al.*, 2021):

- i) Neem's insect-repellent effect, particularly against mosquitoes and aphids, comes from these insects ingesting the sap of neem leaves or flowers, which causes sterility in male mosquitoes. It has also been found to repel flies, and its flowers emit scents imperceptible to humans but repulsive to insects.
- ii) The neem tree contains an active ingredient, azadirachtin, which is found in all parts of the tree but in varying concentrations, with the highest concentrations in the seeds and fruits.
- iii) The tree's leaves contain concentrated active compounds called triterpenoids. These compounds are toxic to insects and effective in controlling agricultural pests. They also have an insect-repellent and feeding-preventing effect, as insects cannot eat neem leaves or leaves sprayed with neem extract. Furthermore, they inhibit molting and insect development by affecting a specific hormone in the insects' blood, the "juvenile" hormone, causing deformities in the different life stages of the insects.
- iv) Neem extract affects the productivity of the second generation, reducing the number of eggs and their fertility. Examples of insects that are affected include the cotton bollworm, aphids, and whiteflies.
- v) It can be used to control pests such as weevils, locusts, beetles, and worms that infest agricultural crops. The active compounds in the tree deter pests from the plants because they find the extract unpalatable, and birds are also repelled by the bitterness it produces.

Insect Development Inhibitors

These are a group of modern chemical compounds that inhibit certain vital processes in insects, such as interfering with the insect's chitin deposition process (preventing chitin formation), or preventing the insect from shedding its old exoskeleton, ultimately leading to the insect's death. MATCH is one of the newest and most potent molting inhibitors for worms that feed on plant leaves and fruits. It affects worms and insects through ingestion and contact



by preventing the formation of the chitin layer necessary for molting. It also has a significant effect on eggs, preventing the hatching of treated eggs (Fredricks *et al.*, 2025). Insect development inhibitors are characterized by their slow action, compatibility with synthetic organic pesticides, sufficient stability on plant surfaces, rapid decomposition in soil and water, and low toxicity to mammals, birds, and fish (Lin *et al.*, 2025).

Insect Growth Regulators (IGRs)

In recent years, a group of modern insecticides has emerged that are characterized by their specificity. They interfere with certain physiological systems unique to insects, arthropods, and are called Insect Growth Regulators (IGRs). These compounds are characterized by their low killing activity and their inability to produce immediate killing action.

This led to the idea of using these substances to control insect pests by disrupting growth and development processes, ultimately leading to insect death. This group includes several hormones, most notably molting hormone and juvenile hormone. (Clifton & Lopez, 2025) a- Molting hormone: This hormone is essential for the absorption of old slough, deposition, hardening, and tanning of new slough. It is also necessary for the molting process. The natural molting hormone that the insect produces in appropriate quantities and at the right time is responsible for the molting process. However, treating insects with this hormone at the wrong time and in sufficient concentration usually leads to the death of insects in all their developmental stages, just like traditional pesticides (Campos *et al.*, 2023). B- Juvenil hormone (JH) prevents the insect from maturing and completing its growth. When these hormones are used for control purposes, they do not kill insects directly, but they interfere with the mechanisms of natural development, leading to the death of insects before they reach the adult stages. Juvenil hormone is synthesized and secreted from a gland in the insect's head (corpora allata). When the gland is removed, the insect transforms into the pupa or adult stage. Therefore, this hormone is very necessary to prevent the insect's development during its life cycle.

When the insect reaches a suitable size, it stops feeding and molts into the pupa stage. Molting occurs when the level of juvenil hormone decreases. Therefore, treating the last larval stage with juvenil hormone causes the larva to molt into an intermediate stage between larva and pupa, or it may molt into a larval stage that continues to feed. If the hormonal supply outside the insect's body is interrupted, it may molt, forming a giant pupa, and subsequently transform into a giant adult insect. Most of these cases die quickly after or during molt, and the juvenile hormone disappears during the transformation from pupa to adult. Treating pupae with juvenile hormone results in an intermediate state between pupa and adult, or the pupa may molt back into a pupa. The end result in both cases is the production of deformed insects that live only a few days but cannot reproduce. It can be said that the presence of juvenile hormone perpetuates incomplete development, while its absence leads to the insect's maturation (Lin *et al.*, 2025).

Most insect species respond to treatment with these hormones by forming unusual forms of larval, nymphal, or pupal stages. The most sensitive metamorphic stages to these



hormones are the larval or late nymphal stage and the pupal stage. Therefore, the appropriate timing for applying juvenile hormones plays a crucial role in the success of the control process. In practice, these hormones can be used in some cases with the aim of It reduces insect pest populations by preventing pupal development and adult emergence, thus keeping the insects in their immature stages until they eventually die. Methoprin and R-20458 are among the insecticides used to inhibit the development and growth of lepidopteran larvae and to stop molting (Lin *et al.*, 2025)

Integrated Pest Management

It is a strategy that combines organic farming and biological control, and pesticides are used only when necessary, relying on careful monitoring of insects (Zhang & Zhang, 2024).

Light- and Sound-Based Pest Control

Insects are attracted using ultraviolet (UV) light traps and then killed. Vibrations that affect insect behavior or disrupt communication between them can also be used.

PRECISION AGRICULTURE

Precision agriculture uses advanced technologies, such as geographic information systems and remote sensing, and relies on satellites and drones to monitor infestation areas and accurately determine the level of the insect, enhance resource efficiency, improve crop productivity, and reduce environmental degradation (Fathi *et al.*, 2025).

CONCLUSION AND RECOMMENDATIONS

The review demonstrates that organic farming represents one of the most important sustainable methods for preserving the environment and producing safe food while reducing reliance on chemical pesticides. Furthermore, modern pest control technologies, such as pheromones, repellents, disinfectants, feeding deterrents, and growth regulators, have contributed to the development of more efficient and less harmful methods for both humans and the environment.

Implementing integrated pest management programs and precision agriculture are among the best strategies for achieving effective pest management while optimizing the use of agricultural resources. Integrating modern technologies with the principles of organic farming also contributes to increased crop productivity, the preservation of biodiversity, and the reduction of environmental pollution. Therefore, expanding the adoption of these technologies and supporting research and training in their application is a fundamental step towards achieving sustainable agricultural development and food security. The study recommends the following points:

- i. Expand the application of organic farming to reduce the use of pesticides and chemical fertilizers and protect the environment.
- ii. Adopt integrated pest management (IPM) programs and combine biological, mechanical, and chemical methods when necessary



- iii. Encourage the use of modern technologies such as pheromones, feeding inhibitors, and insect growth regulators in pest control.
- iv. Employ precision agriculture technologies, such as satellites and drones, to monitor pests and accurately pinpoint their infestations.
- v. Support agricultural research and training to develop the use of modern technologies, achieve sustainable agricultural production, and enhance food security.

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