

Natural Enemies of Major Arthropod Pests

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Agricultural production worldwide is continuously threatened by arthropod pests that feed on crops, transmit plant diseases, and cause severe yield and economic losses. The heavy reliance on synthetic pesticides to manage these pests has resulted in pesticide resistance, resurgence of pests, elimination of beneficial organisms, and environmental contamination. Therefore, the role of natural enemies in regulating pest populations is gaining increasing recognition in sustainable agriculture. Natural enemies include predators, parasitoids, and pathogens that attack and suppress insect pests without harming the environment. They form the ecological foundation of biological control and play a pivotal role in Integrated Pest Management (IPM) systems. This article provides a comprehensive review of the major groups of natural enemies, their role against common arthropod pests, their ecological importance, the benefits of their use, and challenges associated with their effective utilization. Strengthening research, farmer awareness, and mass multiplication of natural enemies can reduce chemical

dependence and promote long-term agricultural sustainability.

Arthropod pests such as insects and mites are among the most damaging constraints in agriculture. Globally, more than 30–40% of crop yield losses are attributed to pest infestations each year. Farmers often depend on chemical pesticides for immediate results; however, indiscriminate use leads to several drawbacks, including pesticide residues in food, health hazards, destruction of biodiversity, and the development of resistance in pest populations.

In this context, natural enemies—which include organisms that prey, parasitize, or infect pests—offer a safe and ecologically sound alternative. Natural enemies have evolved along with pest species and play a central role in regulating their populations in natural ecosystems. Their deliberate use in farming systems is a cornerstone of biological control, an environmentally friendly approach that minimizes chemical input while ensuring long-term pest suppression.

Categories of Natural Enemies



Natural enemies of arthropod pests are broadly classified into predators, parasitoids, and pathogens. Each group functions differently in nature, contributing collectively to pest regulation.

Predators

Predators are free-living organisms that attack, kill, and consume multiple prey during their lifetime. Unlike parasitoids, which depend on one host, predators require numerous pest individuals to complete their development. Many predators are generalists, feeding on a wide variety of pest species, which makes them versatile in pest suppression.

Examples of Predators

Ladybird beetles (*Coccinellidae*): Feed on aphids, mealybugs, and whiteflies.

Lacewings (*Chrysopidae*): Larvae prey on aphids, thrips, and mites.

Syrphid flies (*Syrphidae*): Maggots are efficient aphid predators.

Spiders (*Araneae*): Generalist predators of moths, leafhoppers, and flies.

Predatory bugs (*Anthocoridae*, *Reduviidae*): Attack thrips, leafhoppers, and caterpillars.

Predatory mites (*Phytoseiidae*): Feed on phytophagous mites such as *Tetranychus urticae*.

Parasitoids

Parasitoids are insects that lay their eggs in or on the bodies of other arthropods. The developing larvae consume the host internally or externally, ultimately killing it. They are highly host-specific, which makes them reliable and safe agents for targeted biological control.

Examples of Parasitoids

Egg Parasitoids: *Trichogramma spp.* parasitize eggs of lepidopteran pests.

Larval Parasitoids: *Cotesia spp.* attack caterpillars such as *Helicoverpa armigera*.

Pupal Parasitoids: *Brachymeria spp.* attack pupae of lepidopterans.

Aphid Parasitoids: *Aphidius spp.* are effective against several aphid species.

***Encarsia formosa*:** Widely used against greenhouse whiteflies.

Pathogens (*Entomopathogens*)

Pathogens are microorganisms that infect and kill insect pests. They often cause epizootics in pest populations under favorable conditions. Entomopathogens are formulated into biopesticides and sprayed like chemical pesticides, but without harmful residues.

Examples of Pathogens

Fungi: *Beauveria bassiana*, *Metarhizium anisopliae* infect whiteflies, beetles, termites, and aphids.

Bacteria: *Bacillus thuringiensis* (Bt) produces toxins lethal to caterpillars.

Viruses: Nuclear Polyhedrosis Viruses (NPV) and Granulosis Viruses (GV) target *Helicoverpa* and *Spodoptera*.

Nematodes: *Steinernema* and *Heterorhabditis* species kill soil-dwelling larvae.

Benefits of Natural Enemies

Environmentally safe: No chemical residues or pollution.

Sustainable: Provide long-term, self-perpetuating pest control.

Specificity: Parasitoids and pathogens often target specific pests.

Cost-effective: After establishment, they require little input.

Resistance management: Reduce the risk of pesticide resistance.

Biodiversity conservation: Protect natural ecological balance.

Challenges in Utilization

- Slow action compared to chemicals.
- Environmental dependency (temperature, humidity, pesticide residues).
- Mass production requires specialized facilities.
- Pesticide compatibility issues.
- Lack of farmer awareness and training.

Role in Integrated Pest Management (IPM)

Natural enemies are a cornerstone of IPM programs, which combine cultural, mechanical, biological, and chemical methods. Their role includes:

Releasing Trichogramma cards in rice, sugarcane, and cotton.

Spraying Bt formulations against caterpillars.

Introducing *Cryptolaemus montrouzieri* beetles to control mealybugs.

Conserving spiders and predatory mites by reducing pesticide use.

Conclusion

The use of natural enemies of major arthropod pests represents one of the most effective and sustainable approaches to pest management. Predators, parasitoids, and pathogens contribute significantly to reducing pest populations and form an essential component of modern Integrated Pest Management. While challenges such as mass production and farmer awareness persist, advancements in biological control technologies and increasing recognition of ecological farming systems are creating new opportunities. Strengthening extension services, farmer training, and supportive policies will further enhance the adoption of natural enemies in crop protection.

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