



ISSN: 2230-9926

Available online at <http://www.journalijdr.com>

IJDR

International Journal of Development Research

Vol. 16 Issue, 04, pp. 70365-70368, April, 2026

<https://doi.org/10.37118/ijdr.30829.04.2026>



REVIEW ARTICLE

OPEN ACCESS

BIOLOGICAL CONTROL OF INSECT PESTS WITH PREDATORY ARTHROPODS: A MINI-REVIEW

Bojórquez-Bueno Diana Anabaylutzi¹, Velázquez-Cervantes Mabel Ariana¹, Espinoza-Aguirre Laura Francisca², Romo-Valdez Ana Mireya³, Portillo-Loera Jesús José⁴, Rubio-Aragón Walter Arturo⁵, Edeza-Urías Jorge Alberto⁶ and Romo-Rubio Javier Alonso^{4*}

¹Estudiante de Maestría en Ciencias Agropecuarias, adscrita a la Facultad de Agronomía de la Universidad Autónoma de Sinaloa (FA-UAS); ²Estudiante de Doctorado en Ciencias Agropecuarias, adscrita a la Facultad de Medicina Veterinaria y Zootecnia de la Universidad Autónoma de Sinaloa (FMVZ-UAS); ³Profesora de Tiempo Parcial en la FMVZ-UAS; ⁴Profesor e Investigador de Tiempo Completo adscrito a la FMVZ-UAS; ⁵Profesor e Investigador de Tiempo Parcial adscrito a la Facultad de Ciencias Económicas, Administrativas y Tecnológicas de la Universidad Autónoma de Sinaloa; ⁶Profesor e Investigador de Tiempo Parcial adscrito al Departamento de Ingeniería y Tecnología de la Universidad Autónoma de Occidente. Boulevard San Ángel 3080, Fraccionamiento San Benito, Culiacán Rosales, Sinaloa, México; CP 80246

ARTICLE INFO

Article History:

Received 20th January, 2026
Received in revised form
14th February, 2026
Accepted 19th March, 2026
Published online 30th April, 2026

Key Words:

Biocontrol agents, Natural enemies, Ecological regulation, Sustainable Pest Control, Integrated Pest Management.

*Corresponding author:

Romo-Rubio Javier Alonso

ABSTRACT

The intensive use of synthetic insecticides for pest control in agricultural systems has led to problems of resistance, environmental contamination, and risks to human health, which has driven the development of sustainable Integrated Pest Management strategies. The objective of this work was to document the use of predatory arthropods in the biological control of insect pests in agricultural crops. The reviewed scientific evidence indicates that the main predators belong to the classes Arachnida and Insecta. In the class Arachnida, predatory mites of the family Phytoseiidae stand out for their effectiveness in controlling thrips and whiteflies, while species from the families Laelapidae and Parasitidae show potential for managing soil pests. In the class Insecta, the families Coccinellidae, Syrphidae, Anthocoridae, Miridae, Chrysopidae, and Hemerobiidae show high effectiveness in controlling aphids, psyllids, springtails, flies, lepidopteran larvae and mealybugs. In conclusion, predatory arthropods are an effective and environmentally sustainable tool that can be successfully used in Integrated Pest Management programs, contributing to more balanced and sustainable agriculture.

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Citation: Bojórquez-Bueno Diana Anabaylutzi, Velázquez-Cervantes Mabel Ariana, Espinoza-Aguirre Laura Francisca, Romo-Valdez Ana Mireya, Portillo-Loera Jesús José, Rubio-Aragón Walter Arturo, Edeza-Urías Jorge Alberto and Romo-Rubio Javier Alonso, 2026. "Biological Control of Insect Pests with Predatory Arthropods: A Mini-Review". *International Journal of Development Research*, 16, (04), 70365-70368.

INTRODUCTION

Insect pests are among the main factors limiting agricultural productivity and food security worldwide, causing direct crop damage and substantial economic losses (Savary *et al.*, 2019). Among the numerous pests in agriculture, whiteflies, aphids, thrips, and lepidopterans are considered major groups whose control has historically relied on the intensive use of synthetic insecticides. However, this strategy has generated serious problems such as pest resistance, the presence of residues in food, and environmental contamination (Zelaya-Molina *et al.*, 2022). Agricultural systems characterized by monocultures, excessive use of pesticides, and ongoing environmental changes have favored the proliferation and geographic expansion of numerous pest species, increasing their annual number of generations and their impact on crops where they

previously did not represent a significant phytosanitary threat (Skendžić *et al.*, 2021). In this context, the adoption of more sustainable management strategies is essential, enabling the regulation of pest populations while safeguarding human health and agroecosystem integrity. Biological control, defined as the use of natural enemies (predators, parasitoids, or pathogens) to reduce populations of harmful organisms, represents an effective and environmentally compatible alternative within Integrated Pest Management programs (Cañedo *et al.*, 2011; Hernández-Trejo *et al.*, 2019). Predatory arthropods, belonging to the classes Insecta and Arachnida, have demonstrated a strong capacity to regulate pest insect populations by feeding on multiple prey throughout their life cycle (Urbaneja *et al.*, 2005). Their conservation and augmentation through commercial availability of these beneficial organisms has gained relevance in intensive agricultural systems, particularly in protected crops, where sustained growth in the adoption of biological

control has been documented as a central strategy to reduce dependence on chemical insecticides and promote more sustainable production (Pilkington *et al.*, 2010; Van Lenteren *et al.*, 2025; Calvo *et al.*, 2025). The objective of this work was to document the use of predatory arthropods in the biological control of insect pests in agricultural crops.

mites of the family Phytoseiidae stand out for their high efficacy in controlling thrips and whiteflies, particularly *Frankliniella occidentalis* in various horticultural and fruit crops (Abou *et al.*, 2024). Likewise, species from the families Laelapidae and Parasitidae have shown potential for controlling thrips pupae and other soil organisms, although their application is still limited compared to

Table 1. Predatory arthropods used in the biological control of insect pests in agriculture

Class	Order / Sub class	Family	Members	Target pest groups	References
Arachnida	Acari	Phytoseiidae	<i>Amblyseius cucumeris</i> , <i>A. swirskii</i> , <i>Iphiseius degenerans</i> , <i>Neoseiulus californicus</i> , <i>N. fallacis</i> , <i>Galendromus occidentalis</i> , and <i>Phytoseiulus persimilis</i>	Thrips and whiteflies	Abou <i>et al.</i> , 2024; Xiao-Tong <i>et al.</i> , 2023
Arachnida	Acari	Laelapidae	<i>Gaeolaelaps aculeifer</i>	Thrips	Navarro-Campos <i>et al.</i> , 2020; Castro-López and Martínez-Osorio, 2022
Arachnida	Acari	Parasitidae	<i>Parasitus bituberous</i>	Thrips and dipteran flies	Szafrank <i>et al.</i> , 2013; Castro-López and Martínez-Osorio, 2022
Insecta	Coleoptera	Coccinellidae	<i>Propylea quatuordecimpunctata</i> , <i>Adalia bipunctata</i> , <i>Hippodamia variegata</i> , <i>Harmonia axyridis</i> , <i>Cryptolaemus montrouzieri</i> , <i>Diomus pumilio</i> , and <i>Rhyzobius lophanthae</i>	Aphids, mealybugs and psyllids	Valentini <i>et al.</i> , 2025; Papanikolaou <i>et al.</i> , 2020; Xinjuan <i>et al.</i> , 2026; Burgio <i>et al.</i> , 2025; Gómez-Marco <i>et al.</i> , 2022
Insecta	Diptera	Syrphidae	<i>Sphaerophoria ruficornis</i> and <i>Eupeodes corollae</i>	Aphids, thrips, psyllids, whiteflies, mealybugs, springtails and lepidopterans	Rodríguez-Gasol <i>et al.</i> , 2020; Valentini <i>et al.</i> , 2025; Robledo <i>et al.</i> , 2022
Insecta	Hemiptera	Anthoridae	<i>Orius laevigatus</i> , <i>Orius strigicollis</i> , and <i>Anthocoris nemoralis</i>	Thrips and lepidopteran larvae	Aragón-Sánchez <i>et al.</i> , 2018; Paredes <i>et al.</i> , 2014
Insecta	Hemiptera	Miridae	<i>Nesidiocoris tenuis</i> , <i>Macrolophus pygmaeus</i> , and <i>Dicyphus maroccanus</i>	Aphids and whiteflies	Pérez-Hedo and Urbaneja, 2015
Insecta	Neuroptera	Chrysopidae	<i>Chrysoperla carnea</i> , <i>C. agilis</i> , <i>C. rufilabris</i> , and <i>C. comanche</i>	Aphids and psyllids	Papanikolaou <i>et al.</i> , 2020; Ntalia <i>et al.</i> , 2022; Gómez-Marco <i>et al.</i> , 2022
Insecta	Neuroptera	Hemerobiidae	<i>Micromus angulatus</i> , <i>Sympherobius fallax</i> , and <i>Sympherobius barberi</i>	Aphids and psyllids	Valentini <i>et al.</i> , 2025; Pekas <i>et al.</i> , 2023; Gómez-Marco <i>et al.</i> , 2022

Source: Prepared by the authors based on the literature cited in this work

Main Insect Pests in Agricultural Crops: Insect pests are one of the main causes of economic losses in agriculture, directly damaging crops and affecting their yield and quality (Cañedo *et al.*, 2011; Savary *et al.*, 2019). Among the most relevant species are whiteflies (*Bemisia tabaci* and *Trialeurodes vaporariorum*), thrips (*Thrips tabaci* and *Frankliniella occidentalis*), and aphids (*Aphis gossypii* and *Myzus persicae*), which affect a wide variety of horticultural and fruit crops. Factors such as monoculture, excessive insecticide use, and environmental changes have favored the proliferation and geographic expansion of these pests, increasing their number of annual generations and their impact on agricultural systems (Skendžić *et al.*, 2021). Given this scenario, biological control emerges as a key strategy to reduce pest populations to levels that do not cause economic damage, within the framework of Integrated Pest Management (Cañedo *et al.*, 2011).

Biological control of insect pests in agricultural crops: Biological control is defined as the use of natural enemies (predators, parasitoids, or pathogens) to regulate pest populations. It can be applied through different strategies such as conservation, augmentation, or introduction control (Almaraz-Valle and Ramírez, 2025). This tool has seen remarkable development in intensive agricultural systems and protected crops, where it has proven to be an effective alternative to chemical strategies (Pilkington *et al.*, 2010). In Latin America, the use of biological control has increased significantly in recent decades, covering millions of hectares managed under this approach as a response to insecticide resistance and the need for more sustainable agriculture (Van Lenteren *et al.*, 2025). In this context, predatory arthropods constitute one of the most important groups due to their ability to consume multiple prey and adapt to diverse farming systems (Mason, 2021).

Main groups of predatory arthropods: The predatory arthropods used in biological control belong mainly to the classes Arachnida and Insecta (Urbaneja *et al.*, 2005). Within the class Arachnida, predatory

Phytoseiids (Szafrank *et al.*, 2013; Navarro-Campos *et al.*, 2020; Castro-López and Martínez-Osorio, 2022). In the class Insecta, the most used predators belong to the orders Coleoptera, Diptera, Hemiptera, and Neuroptera. The families Coccinellidae and Syrphidae are highly effective in controlling Aphids, thrips, psyllids, whiteflies, mealybugs, psyllids, springtails, and lepidopterans while Anthoridae and Miridae are prominent in managing thrips, whiteflies, aphids and lepidoptera larvae (Pérez-Hedo and Urbaneja, 2015; Papanikolaou *et al.*, 2020; Valentini *et al.*, 2025). For their part, neuropterans of the families Chrysopidae and Hemerobiidae exhibit a broad prey spectrum and high potential within augmentative biological control programs (Contreras-Ramos and Rosas, 2014; Ntalia *et al.*, 2022; Pekas *et al.*, 2023). Additionally, although with a different approach, species of the order Odonata have been documented as predatory against *Aedes aegypti* larvae, demonstrating the broad functional diversity of predatory arthropods (Akram and Ali Khan, 2016). Table 1 presents the classification of the most relevant predatory arthropods used in the biological control of insect pests in agricultural crops. Insect pests have been identified as a major cause of losses in agricultural production, especially in intensive systems characterized by monocultures and recurrent use of agrochemicals (Savary *et al.*, 2019; Skendžić *et al.*, 2021). Dependence on chemical control has generated undesirable effects such as pest resistance, environmental contamination, and harm to non-target organisms, reinforcing the need for alternative and sustainable strategies (Zelaya-Molina *et al.*, 2022). In this regard, biological control using predatory arthropods is becoming an effective tool within Integrated Pest Management, reducing insect pest populations below the economic damage threshold without disrupting the ecological balance (Cañedo *et al.*, 2011; Hernández-Trejo *et al.*, 2019). In this regard, there is a wide diversity of predators with proven high efficacy, both in the class Arachnida, primarily in the family Phytoseiidae, and in the class Insecta, where families such as Coccinellidae, Syrphidae, Anthoridae, Miridae, Chrysopidae, and Hemerobiidae stand out (Urbaneja *et al.*, 2005; Mason, 2021). Furthermore, it has been

indicated that the combined use of different predators or their integration with other natural enemies increases control efficacy, particularly in protected crops and intensive agricultural systems (Pilkington *et al.*, 2010; Burgio *et al.*, 2025). However, areas where research is limited have also been identified, especially regarding soil predators belonging to the families Laelapidae and Parasitidae, which represents opportunities for future studies (Navarro-Campos *et al.*, 2020; Castro-López and Martínez-Osorio, 2022). Overall, the reviewed scientific evidence indicates that biological control with predatory arthropods constitutes a viable and sustainable strategy for controlling insect pests in agriculture.

CONCLUSIONS

There is a wide diversity of predatory arthropods for the biological control of insect pests in agricultural systems. In the class Arachnida, predatory mites of the family Phytoseiidae stand out for their effectiveness in controlling thrips, and whiteflies, while the families Laelapidae and Parasitidae show potential for managing pests such as dipteran flies and soil thrips, although with less applied development. In the class Insecta, predators from the families Coccinellidae, Syrphidae, Anthocoridae, Miridae, Chrysopidae, and Hemerobiidae stand out, with high effectiveness in controlling aphids, psyllids, and mealybugs, whiteflies, springtails, and lepidopterans. The use of predatory arthropods is an effective and environmentally sustainable tool that can be successfully integrated into Integrated Pest Management programs, contributing to reducing the use of chemical insecticides and promoting more balanced and sustainable agricultural systems.

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