Acta Agrícola y Pecuaria 12: e0121033. | e-ISSN: 2395-874X.
https://doi.org/10.30973/aap/2026.12.0121033 (September 8th, 2026)

SCIENTIFIC NOTE

Arthropod abundance in a maize monoculture: a comparative study of agroecological and conventional management in Morelos, Mexico

Abundancia de artrópodos en un monocultivo de maíz: un estudio comparativo de manejo agroecológico y convencional en Morelos, México

Agustín Jesús Gonzaga-Segura[1,2], **Humberto Reyes-Prado**[1*], **Tonatiuh Ocampo Navarro**[1], **Juan Manuel Rivas-González**[1]

[1] Universidad Autonoma del Estado de Morelos, Escuela de Estudios Superiores Jicarero, Laboratorio de Ecoetologia de Insectos, carretera Galeana-Tequesquitengo s/n, 62909, Jojutla de Juarez, Morelos, Mexico.

[2] Secretaria de Ciencia, Humanidades, Tecnologia e Innovacion-Centro de Desarrollo de Productos Bioticos-Instituto Politecnico Nacional, Laboratorio de Entomologia, km 8.5 carretera Yautepec-Jojutla de Juarez, 62731, Yautepec, Morelos, Mexico.

*Author for correspondence: humberto.reyes@uaem.mx

Reception date:
March 15th, 2026

Acceptation date:
June 25th, 2026

Published on line:
September 8th, 2026

How to cite:
Gonzaga-Segura, A. J., Reyes-Prado, H., Ocampo Navarro, T., & Rivas-González, J. M. (2026). Arthropod abundance in a maize monoculture: a comparative study of agroecological and conventional management in Morelos, Mexico. *Acta Agrícola y Pecuaria, 12*, e0121033. https://doi.org/10.30973/aap/2026.12.0121033

ABSTRACT

Arthropods are key components of agroecosystems due to their contributions to biological control, pollination, and organic matter decomposition. This study compared arthropod abundance in three maize monoculture systems in Morelos, Mexico: conventional (with agrochemical inputs), agroecological, and agronatural (without external inputs). The study was conducted from July to September 2024. A 2,400 m^2 plot was established in each system, and weekly sampling was carried out using an entomological sweep net at five fixed sampling points, complemented by additional zigzag transects along the field margins. Arthropods were identified to the order level, and their abundance was recorded. Twelve arthropod orders were detected, with Diptera, Coleoptera, Hemiptera, and Araneae being the most abundant. The agronatural system showed the highest abundance (931 individuals), followed by the agroecological (729 individuals), and conventional systems (116 individuals). Significant differences were found among systems ($p < 0.05$), suggesting that reducing chemical inputs promote greater arthropod abundance and the associated ecosystem services.

KEYWORDS

Agroecology, arthropod fauna, agricultural management.

RESUMEN

Los artrópodos son componentes clave de los agroecosistemas por su contribución al control biológico, la polinización y la descomposición de la materia orgánica. Este estudio comparó la abundancia de artrópodos en tres sistemas de monocultivo de maíz en Morelos, México: convencional con agroquímicos, agroecológico y agronatural (sin insumos externos). El estudio se realizó de julio a septiembre de 2024. En cada sistema se estableció una parcela de 2,400 m^2 y se realizaron muestreos semanales con una red entomológica en cinco puntos fijos y recorridos adicionales en zigzag en los bordes. Los artrópodos fueron identificados a nivel de orden y se registró su abundancia. Se detectaron doce órdenes, predominando Diptera, Coleoptera, Hemiptera y Araneae. El sistema agronatural presentó la mayor abundancia (931 individuos), seguido del agroecológico (729 individuos), y del convencional (116 individuos). Se encontraron diferencias significativas entre sistemas ($p < 0.05$), lo que sugiere que reducir insumos químicos favorece la abundancia de artrópodos y los servicios ecosistémicos asociados.

PALABRAS CLAVE

Agroecología, artropofauna, gestión agrícola.

Agricultural systems have been modified to maximize production, often through the intensive use of chemical inputs (Brunelle et al., 2024; Țopa et al., 2025). These practices have resulted in ecological imbalances, including biodiversity loss and declines in ecosystem services, particularly those provided by beneficial insects (Bellamy et al., 2018; Jing et al., 2025). In simplified agroecosystems, such as conventionally managed monocultures, reduced plant diversity and agrochemical use negatively affect beneficial arthropods, increasing pest outbreaks and dependence on external inputs (Altieri et al., 2024; Del-Val et al., 2021; Puliga et al., 2024).

Diversifying cropping systems and adopting agroecological practices have been proposed as strategies to restore ecological balance, as these approaches promote complex habitats that support natural enemies, pollinators, and decomposers (Altieri et al., 2024; Blaix et al., 2026). Maize (*Zea mays* L.) cultivation holds significant economic, nutritional, cultural, and social importance in Mexico. Previous studies have demonstrated that maize systems managed under agroecological practices support greater arthropod diversity than conventional systems that rely on agrochemicals (González González et al., 2020; Puliga et al., 2024). However, further research is needed to clarify how different management practices influence arthropod abundance. Therefore, the objective of this study was to compare the abundance among real and spatially isolated maize production systems under different management regimes: agrochemical, agroecological, and agronatural systems without external inputs in Morelos, Mexico.

The study was conducted during the July-September 2024 agricultural cycle. The agroecological (18° 36′50.0″ N, 99° 13′57.4″ W) and agronatural (18° 36′47.1″ N, 99° 13′59.9″ W) systems were established in experimental plots at the Escuela de Estudios Superiores del Jicarero-Universidad Autonoma del Estado de Morelos (EESJ-UAEM) in Jojutla, Morelos, Mexico. The conventional system, managed with agrochemicals, was located in Amayuca, Morelos (18° 42′42.9″ N, 98° 47′57.9″ W). Each plot covered 2,400 m². Plot selection was based on spatial isolation and actual production conditions, emphasizing overall agroecosystem responses while considering the inherent environmental variability of each cropping system.

All systems were planted with the native "Cuarenteño" maize variety obtained from local producers in Xoxocotla, Morelos. Three cultivation systems (treatments) were evaluated:

1) Agrochemical: conventional fertilization practices commonly used in the region were applied, including Triple 16 (three-50 kg bags; 16 % N, 16 % P, and 16 % K), ammonium sulfate (three 50-kg bags), potassium chloride (two 50-kg bags), urea (three 50-kg bags; 46 % N), ferrous sulfate (two 25-kg bags), and Biozyme® TF at 2 L/ha (gibberellins, 32.2 ppm; indoleacetic acid, 32.2 ppm; zeatin, 83.2 ppm; and trace elements: Mg, 0.14 %; S, 0.44 %; B, 0.30 %; Fe, 0.49 %; Mn, 0.12 %; and Zn, 0.37 %) Herbicides included Teuton® at 1 L/ha (nicosulfuron 4.17 %), Takle 360® at 2 L/ha (glysophate isopropylamine salt 41 %; two applications). Insecticides included Semevin FS 350® at 1 L/50 kg seed (thiodicarb 31.5 %), Teniente® at 1 L/ha (chlorpyrifos ethyl 31.65 % and permethrin 4.52 %; two applications), Diazinon Dragón 25E®, 1 L/ha (diazinon 25 %), Lannate® 90 at 250 g/ha (methomyl 90 %), and Counter® FC 5 %, at 20 kg/ha (terbufos 5 %).

2) Agroecological: low-impact inputs were used, including carbonated water (sodium bicarbonate) with biodegradable soap (sodium hydroxide) and neem extract (azadirachtin) as insecticides (375 ml product in 40 L water; two applications), lime sulfur solution as an insecticide and fungicide (250 mL diluted in 15 L water, two application), the entomopathogenic fungus *Metarhizium anisopliae* for soil pest management (150 mL diluted in 15 L water, one application), and vermicompost for fertilization (1 L concentrate/14 L water, three applications).

3) Agronatural: a natural agroecosystem without external inputs (control). Its production is based exclusively on natural processes and resources from the system itself.

Sampling began eight days after planting and continued weekly for ten weeks. Five systematically distributed sampling points ("five golden points") were established in each plot to account for spatial variability. At each sampling point, five sweeps were performed using an entomological net. Additionally, zigzag surveys were conducted along plot edges to complement arthropod records.

Collected arthropods were preserved in 70 % alcohol and transported to the Ecoethology Laboratory at EESJ for identification using taxonomic keys for each insect order (Triplehorn et al., 2005) with the aid of a stereomicroscope (Carl Zeiss Stemi 305, Oberkochen, Germany). For data analysis, abundance values were transformed into ranks and analyzed using analysis of variance (ANOVA) was performed. When significant differences were detected, Tukey's multiple comparison test was applied (p < 0.05). Statistical analysis was performed using Statistix 8.1 (Analytical Sofware, Tallahassee, USA).

A total of 12 arthropod orders were identified across the three maize cultivation systems: Coleoptera, Diptera, Hymenoptera, Hemiptera, Mantodea, Orthoptera, Phasmatodea, Lepidoptera, Diplopoda, Isopoda, Embioptera, and Araneae (Table 1). The conventional system recorded the lowest arthropod abundance, with 116 individuals. In contrast, the agroecological system supported 729 individuals, whereas the agronatural system exhibited the highest abundance, with 931 individuals. Diptera, Coleoptera, and Hemiptera were the most abundant orders. Araneae were substantially more frequent in the agronatural and agroecological systems, but occurred at very low abundance in the conventional system.

Analysis of variance of the mean arthropod abundance across management systems (Figure 1) indicated significant differences ($F_{(2,35)} = 4.91$; $p = 0.0136$). The conventional system showed significantly lower arthropod abundance than the agronatural system. The agroecological system exhibited intermediate abundance and did not differ significantly from that of agronatural system.

These results demonstrate that agricultural management practices significantly influence the abundance of arthropod fauna associated with maize cultivation. The reduction in arthropod abundance observed in conventional systems is consistent with previous studies documenting the negative impacts of intensive agrochemical use on key functional groups, including predators, parasitoids, and pollinators (Del-Val et al., 2021; Estrada-Carmona et al., 2022; Rivers et al., 2016). Although agrochemicals are intended to control insect pests, their application can disrupt interspecific interactions and reduce agroecosystem ecological stability.

The greater abundance of arthropod orders observed in agronatural and agroecological systems suggest that reduced pesticide use favors the conservation of functional arthropod communities. Specifically, the presence of Araneae and Coleoptera may serve as an indicator of enhanced biological control because of their important role as generalist predators of phytophagous insects (Del-Val et al., 2021; Järvinen et al., 2023).

Arthropod abundance in the agroecological system was comparable to that in the agronatural system, suggesting that the use of biological inputs, such as plant extracts and the entomopathogenic fungus *M. anisopliae*, does not negatively impact resident arthropod communities. Similar findings have

Table 1. Abundance of arthropod orders in three maize cultivation systems.

Order or class of arthropods	Agrochemical	Agroecological	Agronatural (control)
Coleoptera	23	154	215
Araneae	1	101	109
Diptera	84	168	260
Hymenoptera	6	28	111
Hemiptera	1	217	157
Mantodea	0	1	1
Orthoptera	0	30	34
Phasmatodea	0	7	3
Lepidoptera	0	23	38
Embioptera	1	0	0
Isopoda	0	0	2
Diplopoda	0	0	1
Total	116	729	931

been reported in maize systems where agroecological practices maintain insect communities comparable to those found in minimally disturbed environments and contribute to the management of soil and foliar pests (González González et al., 2020; Puliga et al., 2024). The greater abundance of Diptera and Hymenoptera in systems with limited pesticide use highlights the ecological importance of these groups in pollination and parasitism of phytophagous species. Their reduction in conventional systems suggests a functional loss that may increase crop susceptibility to pest outbreaks and reinforce dependence on external inputs (Del-Val et al., 2021; Estrada-Carmona et al., 2022).

From an agroecological perspective, these findings reinforce the notion that agricultural intensification through monoculture and agrochemical use leads to simplified biological communities. In contrast, agroecological systems promote greater biological and functional complexity, supporting self-regulation within the agroecosystem and improving the long-term sustainability of maize production (Chavarria et al., 2018; Madsen et al., 2025). Therefore, arthropod fauna can function as bioindicators of agricultural management impacts and represent a key component in the development of sustainable management strategies. The implementation of agroecological practices, commonly used in polyculture and backyard systems at smaller scales, may represent a viable alternative for incorporation into conventional monoculture systems to reduce environmental impacts while conserving ecosystem services.

Acknowledgments

We gratefully acknowledge the support of the Secretaria de Ciencia, Humanidades, Tecnologia e Innovacion for funding project PEE-2025-G-410, which made this research possible.

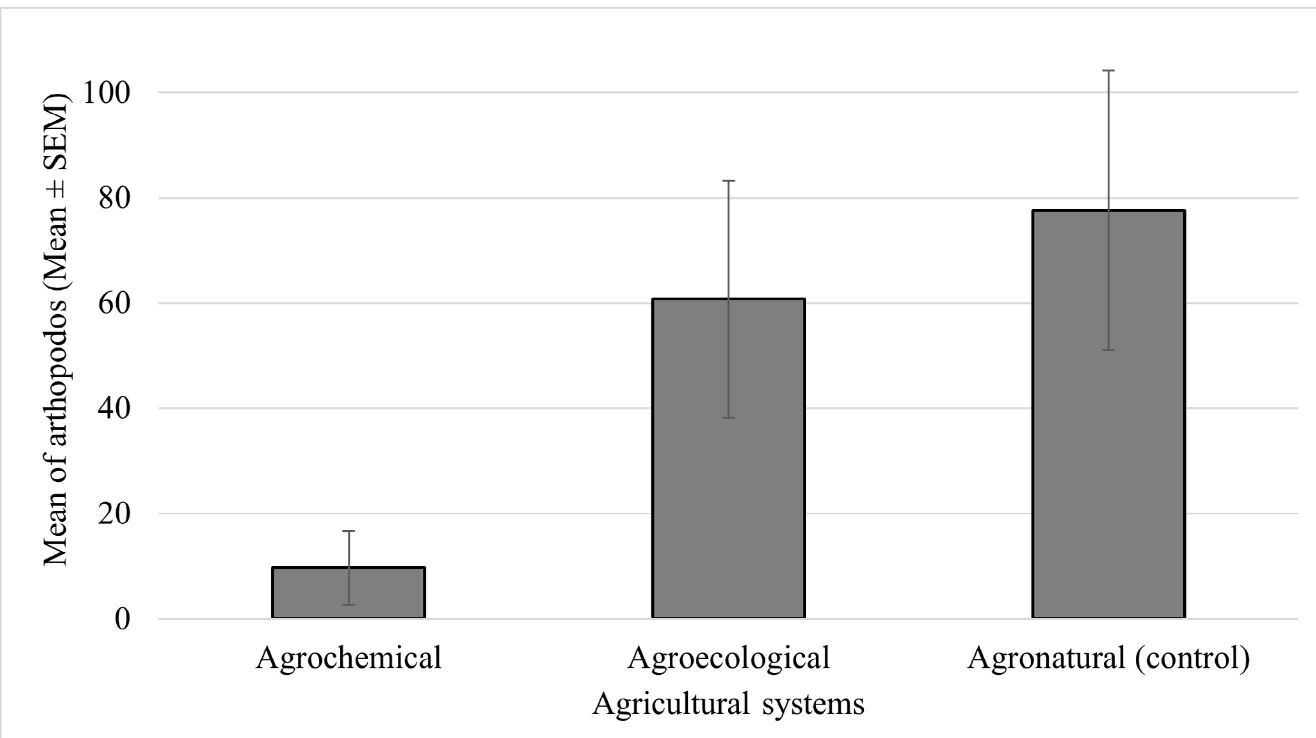

Figure 1. Comparison of arthropods (Mean ± SEM) in different maize cultivation systems. Different letters above the bars indicate statistical differences (ANOVA, Tukey, $p \leq 0.05$).

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