

Article

Preliminary Monitoring of Arthropod Orders in Potato Agroecosystems of Biskra, Algeria

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Received: 26 June 2025

Accepted: 1 July 2025

Citation: Bettiche, F.; Tahar Chaouche, S.; Mancer, H.; Menasria, H.; Chaib, W.; Salemkour, N.; Rouahna, H.; Rechachi, MZ.; Debabeche, K.; Bengouga, Kh.; Bakroune, N. Preliminary Monitoring of Arthropod Orders in Potato Agroecosystems of Biskra, Algeria. *Journal Algérien des Régions Arides* 2025, 18 (2): 1–9

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Abstract: Potato (*Solanum tuberosum* L.) cultivation is expanding in arid regions of Algeria, yet little is known about the associated arthropod communities. This study, part of a CRSTRA-DGRSDT-funded project entitled “Improving Soil Quality in Arid Regions Through the Application of Organic Amendments,” focuses on characterizing insect diversity in potato fields under arid conditions. Two experimental sites: El Hadjeb and El Outaya, in the Biskra region were selected to monitor insect activity during the 2024 growing season. This dual-site monitoring represents the first such effort in Biskra, a region where open-field potato farming remains limited despite its proximity to El Oued, Algeria’s leading production area. The main objective was to document the composition and abundance of arthropod orders, both pest and beneficial, associated with potato crops. Two types of traps: yellow pan traps and Barber pitfall traps were installed at both sites and monitored weekly from early May to mid-June, covering the tuber bulking and maturation phases. Preliminary results showed significant differences in arthropod composition between trap types, sampling dates, and sites. Hymenoptera were the most abundant overall, especially in Barber traps, while Diptera and Lepidoptera were more common in yellow traps. Coleoptera appeared consistently across traps and dates. El Outaya exhibited greater insect activity in June. These findings provide important baseline data for future identification and ecological assessment of insect species in arid potato systems. The ongoing taxonomic identification will help differentiate pests from beneficial insects such as pollinators and parasitoids. This study underscores the importance of biodiversity monitoring in supporting sustainable potato production and integrated pest management strategies in newly developing agricultural zones within Algeria’s arid regions.

Keywords: *Potato agroecosystems; Arthropod diversity; Insect monitoring; Arid regions; Integrated pest management; Ziban*

1. Introduction

Potato (*Solanum tuberosum* L.) ranks as the fourth most widely cultivated food crop in the world, following maize, wheat, and rice [1]. However, in terms of global consumption, it is the third most important staple, underscoring its critical role in food security, human nutrition, and rural livelihoods [2]. Its adaptability to diverse agroecological zones makes it a strategic crop for intensification and diversification in both temperate and arid regions [3].

In recent decades, Algeria has significantly expanded its potato production. In 2023, the country ranked 17th worldwide, producing over 4.63 million tons, and held the second position among African and Arab nations after Egypt (Fig.1) [4]. Despite this high output, the Algerian potato sector continues to face multiple constraints, including erratic climate conditions, increasing water scarcity, declining soil fertility, pest pressures, and limited access to improved seed and technologies [5]. These factors threaten the long-term sustainability and profitability of potato farming.

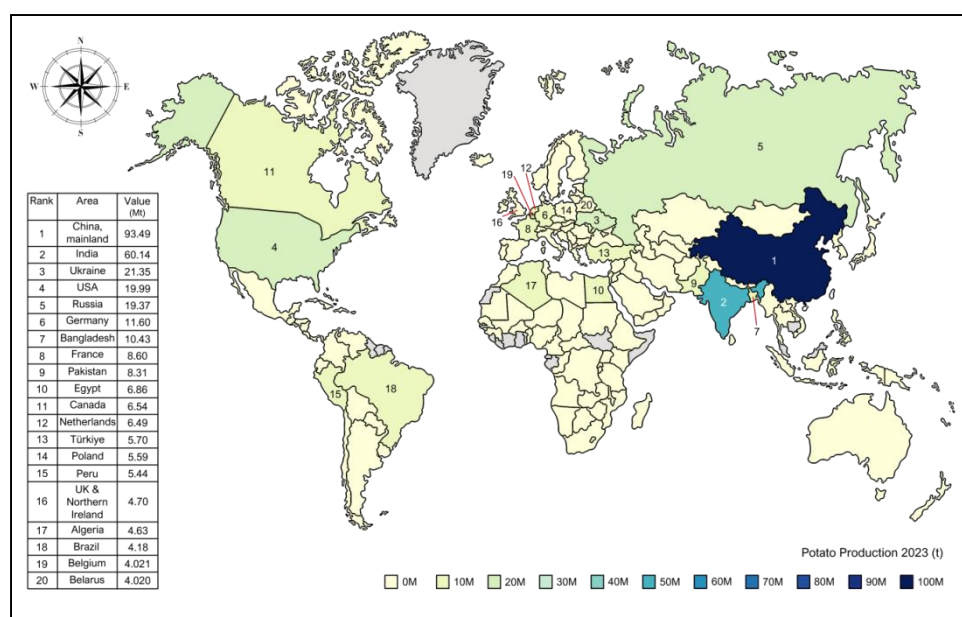


Fig. 1. Global Potato Production and Top Twenty Potato-Producing Countries in 2023 (Million Tons) [4].

Analysis of national data from 2019 reveals significant regional disparities in the phases and productivity of potato production. The El Oued wilaya dominates both the main and late-season cultivation cycles, accounting for over 55% of national production in these periods. In contrast, the Biskra region remains underutilised, particularly for early-season cultivation, despite favourable agro-climatic and edaphic conditions in some zones. In 2019, Biskra accounted for just 2.37% of the area dedicated to early-season potatoes, yet recorded yields (31.67 t/ha) that were considerably higher than the national average (26.08 t/ha) (Table 1) [6]. This suggests substantial untapped potential for expanding production in the region.

In addition to agronomic constraints, pest and arthropod pressures are a major yet often overlooked factor limiting potato yield and quality. These pests, broadly categorized by feeding behaviour into above-ground (indirect) and below-ground (direct) groups, can cause substantial losses if not properly managed [7]. Above-ground pests include aphids (Hemiptera), thrips (Thysanoptera), moths (Lepidoptera), leafminers (Diptera), and leaf beetles such as the Colorado potato beetle (Coleoptera), all of which damage foliage and often act as vectors of viral diseases [8, 9]. Below-ground pests, including wireworms (Coleoptera) and potato tuber moth larvae (Lepidoptera), directly attack tubers and roots, compromising both yield and market quality [8]. Although the negative impact of these pests on crop performance is well documented [10], research on arthropod communities within Algerian potato agroecosystems remains scarce, limiting the development of region-specific, sustainable pest management strategies. As a result, the development of targeted and sustainable pest management strategies is still limited. In particular, studies addressing the diversity, abundance, and ecological roles of insects—whether pests or beneficials—are virtually nonexistent in the Biskra region, where potato farming is still emerging. This discrepancy in knowledge has a detrimental effect on the development of effective and sustainable pest management strategies.

Given this context, the present study aims to contribute baseline data on arthropod diversity in potato fields under arid conditions, focusing specifically on Biskra. To this end, we established two experimental sites—El Hadjeb and El Outaya—where two complementary trapping systems (yellow pan traps and Barber pitfall traps) were deployed throughout the 2024 growing season. The study aims to monitor and identify insect orders present during key phenological stages of the crop, laying the foundation for future ecological research and integrated pest management approaches in arid potato-producing regions.

Table 1. Area, Production, and Yield of Early-, Main-, and Late-Season Potato Crops in Biskra and El Oued Compared to the National Level in 2019 [6].

	Early -Season Potato				
Provinces	Area (ha)	Area (%)	Production (t)	Production (%)	Yield (t/ha)
Biskra	108	2.37	3420	2.88	31.67
El Oued	0	0	0	0	0
Total Algeria	4547	100	118597.3	100	26.08
	Main-Season Potato				
Biskra	0	0	0	0	0
El Oued	10000	11.71	350000	12.01	35
Total Algeria	85 333	100	29 119 98.9	100	34.12
	Late-Season Potato				
Biskra	220	0.32	5990	0.3	27.23
El Oued	27000	39.71	864000	43.42	32
Total Algeria	67983	100	1989653.7	100	29.27

2. Materials and Methods

2.1 Sampling sites

2.1.1 El Hadjeb

The first experimental site is situated in El Hadjeb, within the wilaya of Biskra, on a privately owned farm (coordinates: N 34°44'31", E 005°32'49"). The soil at this location is predominantly sandy, and the field had not been previously cultivated. The crop selected for the study was potato (*Solanum tuberosum*, family Solanaceae), using the Spunta variety. Drip irrigation was implemented to ensure consistent water supply throughout the growing season. Although the experimental plot itself was open-field, the surrounding landscape is primarily dominated by date palm cultivation, with market gardening under plastic greenhouses found somewhat further away. The region is also characterized by frequent winds, particularly during spring and early summer.

The experiment investigated the effect of different organic amendments, including compost (C), bovine manure (B), sheep manure (S), and poultry manure (P). These amendments were applied at varying doses, as detailed in Table 2, which presents their compositional analysis. The application protocol involved splitting the total amount of organic amendment into two fractions: one applied prior to sowing and the other after the emergence of the potato plants. Sowing was conducted between March 6 and 11, 2024, with a planting density of 25 cm between plants and 75 cm between rows. The experimental layout followed a split-plot design with 12 treatments replicated three times. Each experimental unit covered an area of 25 m² (5 m × 5 m). The treatments corresponded to different application rates of organic amendments, specifically 0.25, 0.5, and 1.0 times the nitrogen requirement of the potato crop.

2.1.2 El Outaya

The second experimental site is located in El Outaya, also within the wilaya of Biskra, at the bio-resources station of the Scientific and Technical Research Centre for Arid Regions (CRSTRA). The soil at this site has a clay-loamy texture. Before the start of the experiment, the field had been previously cultivated with okra (*Abelmoschus esculentus*, family Malvaceae). In 2024, okra was recultivated in a nearby plot adjacent to the experimental site. The surrounding area also includes plots of date palms.

As in the first site, the Spunta variety of potato was used, and irrigation was carried out using a drip system. The study evaluated the effects of five types of organic amendments: two types of compost—C1 (a basic compost derived from date palm waste) and C2 (vermicompost)—as well as bovine (B), sheep (S), and poultry (P) manures. These amendments were applied after plant emergence at rates designed to meet the nitrogen requirements of the potato crop.

Sowing was conducted between March 18 and 20, 2024, with a planting density of 25 cm between plants and 75 cm between rows. The experimental design followed a split-plot arrangement consisting of five treatments, each replicated three times. Each experimental unit covered an area of 9 m² (3 m × 3 m).

Although five types of organic amendments were applied at both sites, their effects are not analyzed in this preliminary study. Data were pooled across all treatments to focus exclusively on validated arthropod order-level identifications. The influence of these amendments on arthropod communities will be explored in future studies, once species-level identifications and more comprehensive datasets become available.

2.2 Sampling Method

The sampling system consisted of two types of traps: yellow pan traps (11 cm in height, 28.5 cm upper diameter, and 20.5 cm lower diameter) and Barber pitfall traps (11 cm in depth and 8 cm in diameter), placed at ground level and belowground level, respectively.

At the El Hadjeb site, five yellow pan traps were installed one near each of the four corners and one at the center of the experimental plot. Five Barber traps were also positioned: one at the center of each of the outer rows and one in the middle of the plot (see Fig. 2a).

At the El Outaya site, due to the smaller plot size, only two traps of each type (yellow and Barber) were placed, each in opposite corners of the plot (see Fig. 2b).

Barber and yellow pan traps were filled to one-third and two-thirds of their volume, respectively, with tap water mixed with a few drops of liquid detergent to reduce surface tension and prevent the escape of trapped invertebrates. After each sampling event, the traps were emptied, thoroughly cleaned, and refilled following the same procedure. Insect collections were conducted at approximately seven-day intervals. Each trap was labeled with a unique identification number using a permanent marker to avoid confusion during sampling.

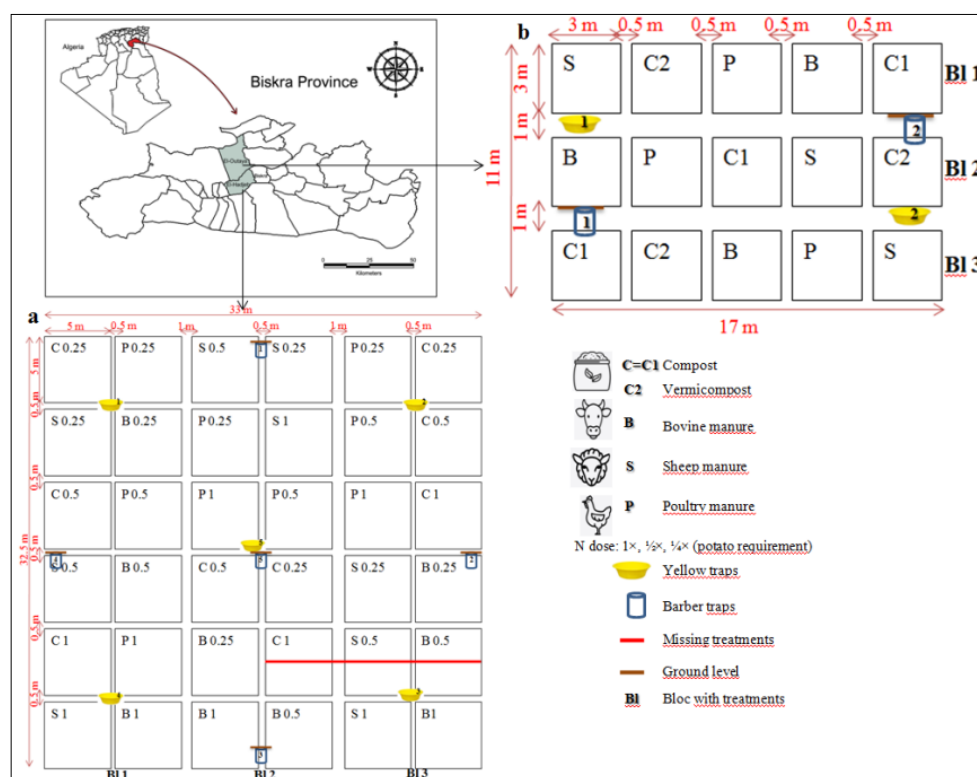


Fig. 2. Map of sampling sites and trap setup: yellow and Barber traps in (a) El Hadjeb and (b) El Outaya.

2.3 Chosen cultivar

The potato cultivar used in this study was ‘Spunta’, a widely grown variety across all bioclimatic regions of Algeria. Its growing period ranges from approximately 90 days [11] to 110 days from planting to harvest [12, 13]. According to the European Cultivated Potato Database (2025) [14], Spunta is an early to mid-season variety with a semi-erect to erect growth habit and dense foliage. It rarely produces flowers or berries, and its sprouts are blue. The tubers are typically oval to elongated, with smooth, white to yellow skin, shallow eyes, and light-yellow flesh. This variety is known for its medium to very high yield potential and good drought tolerance, along with moderate frost resistance. According to the database, Spunta shows varying degrees of resistance to several fungal, bacterial, and viral diseases. However, it exhibits only low resistance to nematodes, and no data are available regarding its resistance to insect or other arthropod pests, indicating a lack of documented resistance in this regard.

3. Results and Discussion

3.1 Summary of Field Operations

Field operations at both sites followed a structured experimental design with clear timelines. El Hadjeb’s sowing occurred from March 6–11, while El Outaya’s sowing was later, from March 18–20. Traps were installed early in May, and sampling occurred during the tuber bulking and maturation phases. El Hadjeb had a slightly longer monitoring period, ending with harvesting in late June, while El Outaya’s harvest extended into early July (Table 2). These staggered timelines facilitated comparative insights into temporal shifts in insect activity.

Table 2. Summary of Field Operations, Including Sowing, Sampling, and Harvesting at the El Hadjeb and El Outaya Sites.

Experimental Sites	El Hadjeb	El Outaya
Field Activities		
Cultivar	Spunta	
Sowing dates	6-11 March 2024	18-20 March 2024
Sowing density	25 × 75 cm (intra × inter-row)	
Trap installation dates	2 May 2024	8 May 2024
Sampling dates (phenological stages)	8, 15, 20 May – Tuber bulking phase 28 May, 4, 12 Jun – Maturation phase	15, 20, 28 May – Tuber bulking 4, 12 Jun – Maturation
Harvesting dates	23-27 June 2024	1-3 July 2024

3.2 Insect Abundance by Order, Site, Trap Type, and Date

3.2.1 Trap Type Comparison (Within Sites)

Barber pitfall traps consistently captured more insects than yellow pan traps at both sites. For example, on May 8 at El Hadjeb, Barber traps collected 264 Hymenoptera compared to 70 in yellow traps. Similar trends were noted for Dermaptera and Lepidoptera. At El Outaya, Barber traps also captured substantially more Hymenoptera (232 vs. 7 on June 12), Diptera, and Coleoptera. Yellow traps tended to capture more Lepidoptera and Diptera on specific dates. This indicates that Barber traps are more effective for ground-dwelling insects, while yellow traps are better suited to capturing flying taxa.

3.2.2 Temporal Comparison (Within Trap Type)

Temporal fluctuations in insect abundance were evident. At El Hadjeb, Hymenoptera peaked early (May 8) and declined thereafter. Diptera and Lepidoptera exhibited intermittent peaks, particularly around late May. At El Outaya, Hymenoptera and Diptera numbers surged in June, reflecting later crop development and site-specific microclimatic conditions. These seasonal shifts underscore the importance of aligning sampling periods with crop phenology to capture key insect dynamics.

3.3 Relative Abundance by Site and Trap

Figures 3 and 4 show that Barber traps at El Hadjeb were dominated by Hymenoptera, while yellow traps recorded higher proportions of Diptera and Coleoptera. Figures 5 and 6 reveal a similar pattern at El Outaya: Barber traps were again dominated by Hymenoptera, followed by Diptera and Coleoptera, while yellow traps captured more Lepidoptera and some Hemiptera. This confirms the complementary nature of both trap types in capturing a broader range of arthropod orders and highlights differences in trap performance by taxonomic group. These findings are consistent with current recommendations in integrated pest management (IPM), which emphasize the importance of using multiple, species-specific monitoring tools to effectively detect a wide range of pest groups. According to [10], effective monitoring is a cornerstone of successful IPM, often requiring the simultaneous use of complementary methods. For instance, Colorado potato beetles (Coleoptera), potato psyllids (Hemiptera), potato ladybird beetles (Coleoptera), and aphids (Hemiptera) are typically monitored through visual inspection of foliage. Pea leafminers (Diptera) are captured using yellow pan traps, sticky yellow cards, or suction traps. In contrast, adults of potato tuber moths and European corn borers (Lepidoptera), as well as click beetles (Coleoptera), respond best to pheromone traps, while wireworms—their larvae—are effectively monitored using baited soil traps.

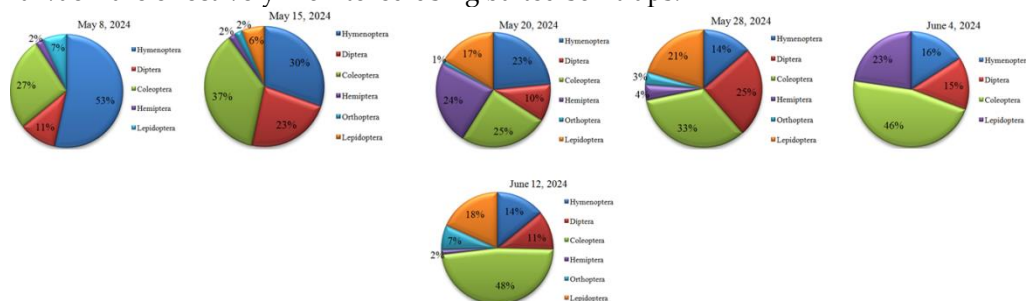


Fig. 3. Percentage significance of insect orders collected with yellow traps over the sampling dates in the potato plot at the El Hadjeb site.

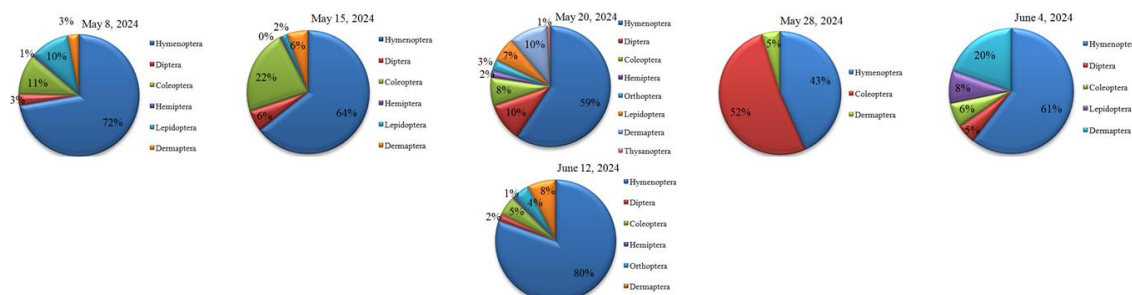


Fig. 4. Percentage significance of insect orders collected with Barber traps over the sampling dates in the potato plot at the El Hadjeb site.

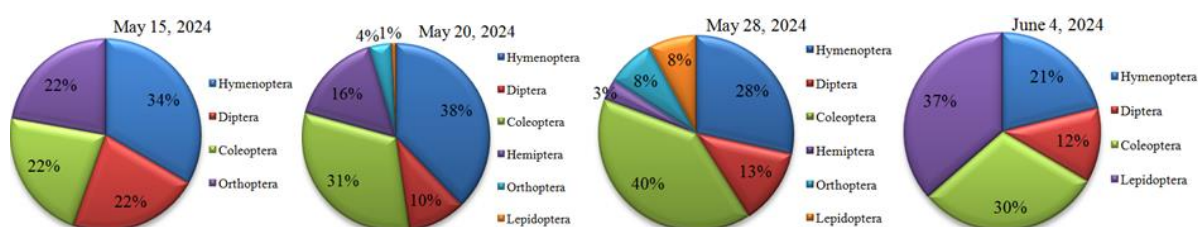


Fig. 5. Percentage significance of insect orders collected with yellow traps over the sampling dates in the potato plot at the El Outaya site.

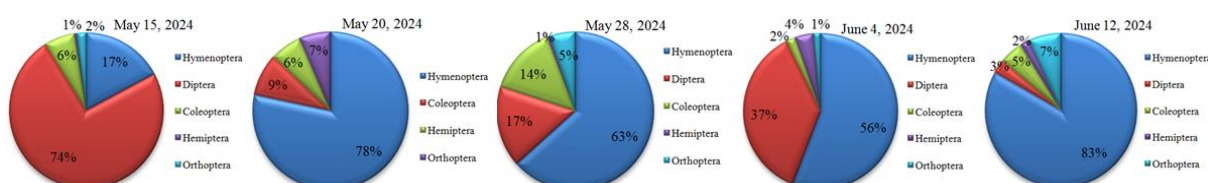


Fig. 6.Percentage significance of insect orders collected with Barber traps over the sampling dates in the potato plot at the El Outaya site.

3.4 Dominant Arthropod Orders

Across both experimental sites and trap types, the most dominant arthropod orders were Hymenoptera, Diptera, and Coleoptera. Hymenoptera were the most abundant overall, particularly in Barber pitfall traps, indicating their strong presence at ground level. Diptera showed high temporal variability and were more frequently captured in yellow pan traps, suggesting their predominantly aerial activity. Coleoptera were consistently recorded across all sampling dates and trap types, reflecting their broad ecological presence. *Lepidoptera* were also frequently captured, especially in yellow traps, while *Dermaptera* were more commonly observed in Barber traps. Although Hemiptera and Orthoptera were less abundant overall, they were present throughout the sampling period, contributing to the overall arthropod diversity in the potato plots. It is noteworthy that the order *Thysanoptera* was recorded only once—represented by a single individual, at a single site (El Hadjeb), captured by one trap type (Barber), and on a single sampling date (June 20) (Table 3).

These patterns are consistent with previous studies conducted in arid regions of Algeria. In a study conducted by [15] in the El Oued province, arthropod communities were surveyed across three stations with varying land uses. The Robbah station, which combined palm groves, market gardening, and potato cultivation, was dominated by Hymenoptera, representing 52.4% of the 191 individuals collected. Other notable orders included Diptera (11.5%), Coleoptera (9.3%), and Araneae (8.4%), while Lepidoptera and several others were weakly represented. El Oglia station, where palm groves and potato crops were cultivated, showed a different pattern: Coleoptera was the most abundant order (33.6%) among the 149 individuals recorded, followed by Hymenoptera (25.2%), with notable occurrences of Araneae (11.4%) and Dermaptera (10.1%). Similarly, in a study by [16] on arthropod community diversity in both sand dune and palm grove ecosystems in the Touggourt region, Hymenoptera emerged as the most dominant order, accounting for 41.81% of the total individuals recorded.

3.5 Site-Level Diversity and Activity

El Hadjeb displayed early peaks in insect abundance, particularly Hymenoptera, while El Outaya experienced higher overall insect counts in June, likely due to its later sowing date and different soil texture. This suggests that site-specific conditions strongly influence arthropod community structure and temporal dynamics.

Table 3. Number of Insect Individuals Identified by Order in Potato Plots, Categorized by Date and Site (El Hadjeb and El Outaya).

Experimental Sites	El Hadjeb												El Outaya											
	May, 2024												June, 2024											
	8	8	15	15	20	20	28	28	4	4	12	12	15	15	20	20	28	28	4	4	12	12		
Trap Type	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.	Yel.	Bar.		
Orders	Total Number of Individuals (5 Traps)												Total Number of Individuals (2 Traps)											
<i>Hymenoptera</i>	70	264	45	127	47	63	16	39	12	86	10	127	3	35	49	36	25	196	7	232	0	84		
<i>Diptera</i>	14	11	34	11	21	11	29	0	11	7	8	3	2	150	13	0	11	51	4	153	0	3		
<i>Coleoptera</i>	35	39	54	44	50	8	39	4	35	9	34	8	2	13	41	4	35	44	10	8	0	5		
<i>Hemiptera</i>	3	2	3	1	47	2	5	0	0	0	1	1	0	1	21	3	3	2	0	16	0	2		
<i>Orthoptera</i>	0	0	3	0	2	3	4	0	0	0	5	7	2	4	5	3	7	16	0	6	0	7		
<i>Lepidoptera</i>	9	38	9	3	33	7	24	0	17	12	13	0	0	0	1	0	7	0	12	0	0	0		
<i>Dermaptera</i>	0	11	0	11	0	11	0	5	0	28	0	12	0	0	0	0	0	0	0	0	0	0		
<i>Thysanoptera</i>	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

Yel.: Yellow trap; Bar.: Barber trap

4. Conclusions

This preliminary study provides essential baseline data on the diversity and abundance of arthropods in the potato agroecosystems of Biskra. This data offers valuable insight into the sustainable management of crops in arid regions. Using both yellow pan and Barber pitfall traps proved effective in capturing a wide range of insect orders. Further analysis, particularly at species level and concerning diversity indices, will be crucial

for distinguishing between pests and beneficial organisms, and for informing integrated pest management strategies.

Several limitations highlight areas for future research. Firstly, species identification is ongoing, and accurate classification is critical for assessing their ecological roles within the agroecosystem. Additionally, as sampling began during the tuber bulking phase, the dynamics of arthropods in the early season remain undocumented. Future monitoring should start at planting and be conducted more frequently in order to capture the full seasonal variation. To improve the quality and completeness of the data, the processing of specimens should be accelerated to prevent degradation. Monitoring should be expanded to multiple sites across Biskra, particularly on farms practicing monoculture (potato-only cultivation) or polyculture (potatoes grown alongside other crops). This broader approach, encompassing a range of agricultural management systems and phytosanitary practices—including pesticide use—will provide a more nuanced understanding of the factors shaping insect diversity. Direct sampling at the soil and tuber levels is also recommended to detect species that may be overlooked by the two trap types used in this study, which primarily target above-ground arthropods and are not effective for subterranean or soil-dwelling organisms. To enhance the accuracy of monitoring, it is therefore advisable to incorporate a broader range of trapping methods, including those specifically designed to collect soil-dwelling insects that attack potato roots and tubers, as well as other types of traps targeting microarthropods such as thrips. Setting up local observatories to monitor the emergence of quarantine or invasive pests would improve phytosanitary surveillance and preparedness for risks.

Given the promising early-season potato yields in Biskra—particularly in areas with favorable soils such as El Hadjeb—it is advisable to promote the expansion of potato cultivation, especially early-season potatoes, by increasing the cultivated areas in the province. However, this should be accompanied by appropriate measures to protect the plots from wind exposure. Furthermore, caution is advised when applying organic amendments, particularly manure sourced from outside regions, to avoid the accidental introduction of unwanted insect species. Addressing these limitations will enhance the quality of future research and support the sustainable development of potato cultivation in Algeria's arid agricultural regions.

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