JOURNAL OF AGRICULTURE AND APPLIED BIOLOGY
2025, Vol. 6, No. 2, 155 - 166
http://dx.doi.org/10.11594/jaab.06.02.02
E-ISSN: 2723-5106

Research Article

Comparatif monitoring arthropod: Auxiliary-pest complex in vineyard table grapes cultivars in Boumerdes vineyards, Northern Algeria

Roumaissa Benmokhtar[1*], Fatma Zohra Bissaad[1], Faiza Marniche[2], Farid Bounaceur[3]

[1]Bioinformatics, Applied Microbiology and Biomolecules Laboratory, Sciences Faculty, M'hamed Bougara University, Algeria.
[2]National Veterinary School (ENSV) El Alia, Algiers. Research Laboratory for the Management of Local Animal Resources (GRAL), National Higher School of Veterinary Science, Algiers, Algeria
[3]Conservation Biology Research Team, Agronomy and Environment Laboratory, Institute of Natural and Life Sciences, Tissemsilt University, Algeria

Article history:

Received 19 August 2024
Revised 16 October 2024
Accepted 17 October 2024
Published 12 February 2025

Keywords:

Color
Insect
Preference
Trap
Vine

***Corresponding author:**

E-mail:
r.benmokhtar@univ-boumerdes.dz

Abstract

As an alternative to chemical treatments, traps are one of the most environmentally friendly ways to control pests in agricultural systems. The efficacy of traps can be maximized by taking adventage of the fact that arthropods, and especially pests, have preferences for certain colors and stimuli. From January to December 2022, in the locality of Corso, situated in Boumerdes Province, Northern Algeria. The experimental site consisted of a three-year-old table grape plantation. A descriptive observational method was employed to assess the performance of four different trap types: pitfall traps, food-based traps, and two color-based traps (yellow and blue). The experiment followed a completely randomized design with five replications to ensure reliable and accurate results. Yellow traps proved to be the most successful throughout the research., capturing a total of 1,925 arthropod individuals. In contrast, food-based traps were the least effective, with only 14 individuals captured. The traps revealed a richness of 106 species spanning 54 families, 11 orders, and 3 classes, highlighting the diverse arthropod community present in the vineyard ecosystem. The most frequently captured species was *Jacobiasca lybica*, which accounted for 81.6% of the total pests trapped. The timing of trap installation was also a critical factor, with the morning period yielding the highest capture rates. These findings underscore the importance of using color-specific traps and strategic timing to enhance pest management in vineyards.

How to cite:
Benmokhtar, R., Bissaad, F. Z., Marniche, F., & Bounaceur, F. (2025). Comparatif monitoring arthropod: Auxiliary-pest complex in vineyard table grapes cultivars in Boumerdes vineyards, Northern Algeria. *Journal of Agriculture and Applied Biology, 6*(2): 155 - 166. doi: 10.11594/jaab.06.02.02

1. Introduction

Viticulture in Algeria has its origins in ancient history, particularly during the period of Roman colonization, as it discovered optimal agro-climatic conditions conducive to its advancement. The practice of viticulture is extensively distributed across the western region of the nation: Tlemcen, Sidi Bel Abbés, and Ain Témouchent serve as the primary wine-producing municipalities in the west; Skikda and Bejaia are situated in the east; and in the central area, the Sahel hills encompass Blida, Médéa, Mitidja, Boumerdes, and Kabylie (Sarmoum et al., 2018).

To effectively control arthropod pests, researchers are inventing integrated pest management (IPM) systems that use fewer pesticides overall and target their administrations more accurately. However, the efficacy of these systems relies on the accuracy of the selected pest population monitoring technique. In addition, it is vital to obtain information on population dynamics and their related ecological parameters in order to establish an effective pest management approach (Deguine et al., 2021; Tartanus & Malusà, 2024).

Monitoring methods and procedures to determine whether the pest population surpasses the economic damage threshold are therefore of essential value for plant protection. Their reliability depends on the linkage of monitoring data with genuine insect population densities in the crop (De Groote, 2022).

Pest and natural enemy monitoring techniques are species specific and are based on direct or indirect observations. Apart from direct counting on the plant, there are many trapping devices available on the market, such as pheromone traps, suction traps, and colored sticky traps. In general, monitoring is time-consuming, and so numerous facilitation aids, i.e., colored sticky traps, pheromone traps, and suction traps, were created.

However, it is vital to regularly monitor arthropod agroecosystem communities in order to understand when and where populations are dropping, identify causes of decreases, and design tailored mitigation strategies. While a growing number of long-term monitoring initiatives emerged in the previous decade, many studies lack comparability as a consequence of diversity in sampling methodologies. Even within monitoring programs, methodologies may change with time and place (Welti et al., 2021). Assessments of how various monitoring systems impact arthropod estimates in grapevine crops are required to permit comparisons. For this research, we evaluate the use of four trap techniques to monitor arthropds in two table grape varieties in one of the first key vineyard regions in Algeria (Boumerdes province). Data acquired will be utilized to pick the optimum monitoring approach to generalize their application in vineyard crops.

2. Materials and methods

2.1. Description of the study area

The research was done in a vineyard situated in the Boumerdes area, more especially in the town of Corso, some 25 kilometers east of Algiers. Corso is a seaside town on the Mediterranean Sea, lying on a plain between the Corso River to the east and the Boudouaou River to the west (Figure 1).

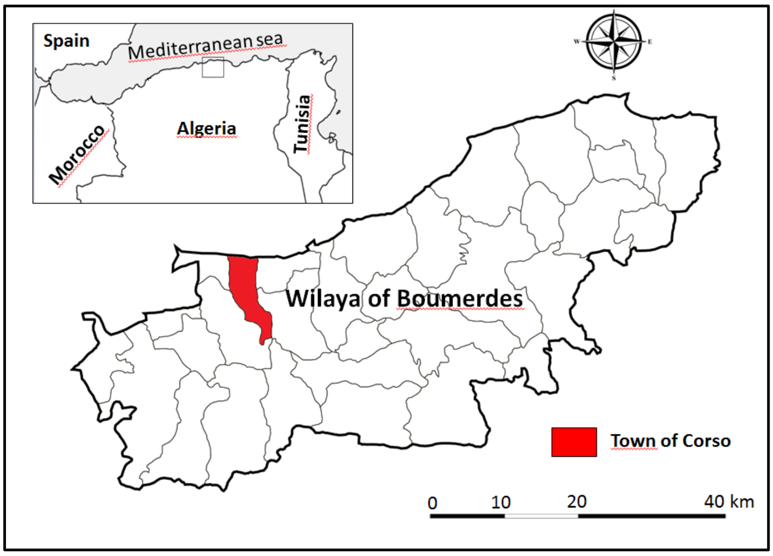

Figure 1. Geographical position of the study area

2.2. Methodology

The research of the richness of the vine entomofauna was conducted in two separate vineyards producing distinct grape varieties: Red Globe and Dabouki. The total area of the two vineyards is 4 hectares, with a total of 2200 plants, of which 3 hectares are planted with Red Globe and 1 hectare with Dabouki. The average age of these vineyards is 3 years. The plots studied are fairly homogeneous and have been regularly tended. The training system used is a pergola with S04 rootstock and drip irrigation.

The Dabouki vineyard is bordered by a field of citrus crops specifically orange trees (*Citrus sinensis*), and a plot of peppers *(Capsicum annuum).* The Red Globe vineyard is encircled by a crop cycle that takes place every season. This rotation includes crops such as beans (*Phaseolus vulgaris*), tomatoes (*Solanum lycopersicum*), watermelons (*Citrullus lanatus*), and cauliflower (*Brassica oleracea* var. botrytis). The vineyards are surrounded by a variety of habitats, including woodlands and meadows, with pine and blackberry trees, herbaceous plants, and wildflowers like papaver rhoeas.

As a preventative measure against pests and fungal diseases, the vineyard was sprayed with insecticides and fungicides in 2021. The rates specified on the labeling of the phytosanitary products were followed. Throughout the entire calendar year, specifically from January 1 to December 30, 2022, samples were systematically collected, thereby facilitating a comprehensive observation of the vine's complete life cycle over a twelve-month duration.

Field trips were made at regular intervals, once every ten days, i.e. three trips per month. A set of traps was used, comprising yellow traps, consisting of five yellow basins, five yellow bottles with soap solution and a yellow sticky plate, and blue traps, consisting of five blue basins and five blue goblets with soap solution. Ten food traps, containing a vinegar solution, were suspended from the vine wires. In addition, ten pitfall traps (Barber pots) were placed in quadrants, two-thirds filled with soapy water (Guermah et al., 2019), to collect walking arthropods. A yellow sticky plate was strategically placed in each of these traps (Figures 2).

The study of biocenosis dynamics led us to adopt a diagonal layout to maximize coverage of the vineyard plots, in line with the method recommended by Southwood and Henderson (2000). According to Vincent and Lasnier (2016), the pit trap is used to capture arthropods walking the ground, mainly ground beetles, spiders, and weevils. All sampling and observations were carried out between 9 a.m. and 1 p.m. (Faurie et al., 2011).

The arthropods gathered were sorted and stored in pillboxes holding alcohol at 70 % in order to be recognized subsequently at the greatest taxonomic rank feasible, especially till the genus and species using a binocular magnifier with a magnification of (*10/20) times. Insects were identified to the order, family, genus, and species levels (when possible) using multiple taxonomic identification keys specific to each insect order.

Figure 2. The sampling method (a: yellow trap, b: blue trap, c: food trap, d: pitfall trap)

2.3. Exploitation of the results

Samples obtained in the field are submitted to numerous studies, concentrating on ecological composition indicators such as total richness and relative abundance, and also on structural ecological indices like the Shannon-Weaver index and equitability.

2.3.1 Ecological composition indices

2.3.1.1. Specific richness

It is one of the key factors typical of a stand, the overall richness (S) of a biocenosis corresponds to all the species that form it (Ramade, 2020).

2.3.1.2. Relative abundance or centesimal frequency

Relative abundance, given as a percentage (AR%), shows the proportion of individuals of a species (ni) in relation to the total number of individuals (N). It is computed by dividing the number of individuals of a species by the total number of individuals, then multiplying by 100 : RA% = (ni / N) x 100 (Faurie et al., 2011).

3. Results and discussion

The sampling results in the vineyard of Corso reveal a remarkable diversity of arthropods, including insects, spiders, and crustaceans. In total, 106 species were recorded, belonging to 54 families, distributed across 11 orders and 3 classes. Insects dominate with 103 species, followed by spiders with 2 species, and a single species of crustacean. These findings underscore the richness and biodiversity within the vineyards studied, particularly in the Red Globe and Dabouki varieties. In total, 2,528 individuals were found in the Corso vineyard, 1,777 in the Dabouki variety and 751 in the Red Globe vineyard.

3.1. Total richness of invertebrate species collected

3.1.1. Total richness of invertebrate species collected in Dabouki cultivar

The total richness of species captured by the four types of traps is 49 species for the yellow traps. 17 species for the blue traps, 6 species for the food traps, and 28 species for the pitfall traps (Table 1). According to the results, the yellow traps were the most effective in capturing the species with a total of 1,562 individuals captured. Next were the pitfall traps with 115 individuals, followed by the blue traps with 88 individuals, and finally the food traps with 12 individuals (Table 1).

Table 1. Total abundance of species captured by different sampling methods in the Dabouki cultivar

Traps	Yellow Traps	Blue Traps	Food Traps	Pitfall traps
Taxa S	49	17	6	28
Individuals	1562	88	12	115

3.1.2. Total richness of invertebrate species caught in Red Globe cultivar

The overall richness of species collected by the four kinds of traps is 43 species for the yellow traps. 26 species for the blue traps, 2 species for the food traps, and 13 species for the pitfall trapss (Table 2). According to the results, the yellow traps were the most effective in capturing the species with a total of 363 individuals captured. Next were the blue traps with 354 individuals, followed by the pitfall traps with 32 individuals, and finally the food traps with only 2 individuals (Table 2).

Table 2. Total abundance of species captured by different sampling methods in the Red Globe cultivar

Traps	Yellow Traps	Blue Traps	Food Traps	Pitfall traps
Taxa S	43	26	2	13
Individuals	363	354	2	32

3.2. Percentage frequency determined for the orders of arthropods collected by the yellow traps

Figure 3 shows the relative abundances of the arthropod orders that were caught using yellow traps in the two types (Dabouki and Red Globe).

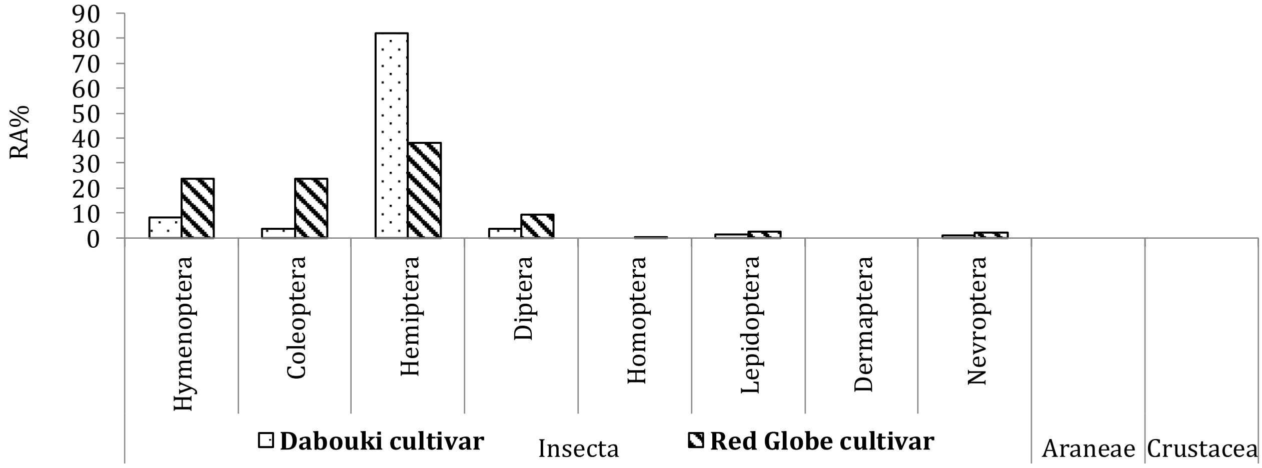

Figure 3. Relative abundance of orders collected by yellow traps

The results show that yellow traps captured species from various insect orders. In the Dabouki grapevine, the most captured order was Hemiptera, accounting for 81.6% of the total catch, followed by Hymenoptera with 8.2%. Diptera and Coleoptera were captured in nearly equal proportions, at 3.8% and 3.6% respectively, followed by Lepidoptera at 1.5%, and Neuroptera at 1.0%.

In the Red Globe grapevine, Hemiptera was again the most frequently captured order, representing 38% of the catch, followed by Hymenoptera and Coleoptera, both with nearly equal proportions. Diptera made up 10% of the captures, with Lepidoptera and Neuroptera being the least represented, a single species from the order Homoptera was recorded.

Our results show that the yellow trap technique proved to be the most effective of all the methods used, capturing the highest number of arthropods. A total of 2,450 individuals were captured, including 1,562 in the Dabouki variety and 363 in the Red Globe variety. The yellow traps attracted a large number of insects from several orders, including Hymenoptera, Lepidoptera, Hemiptera, Homoptera, Coleoptera, Diptera and Neuroptera.

A total of 32,790 insects were distributed across 10 orders and 68 families within the zucchini cultivation, whereas 34,073 insects were disseminated among 10 orders and 65 families through the utilization of yellow traps, as documented by Lozano et al. (2013). We implemented three distinct methodologies using yellow traps, all of which were suspended in the vineyard environment. The initial methodology entailed yellow basins containing soapy water, the second method incorporated yellow bottles also filled with soapy water, and the final approach utilized yellow sticky plates. Each of these techniques proved effective in capturing insects. The yellow trap serves as a widely employed instrument for evaluating the population density of specific beneficial insect taxa, such as dipterans (including hoverflies and tachinid flies) and parasitoid hymenopterans, in addition to pest species like aphids. The trap is characterized by a yellow dish or basin containing a wetting liquid (composed of water mixed with soap or alcohol) in which insects, lured by the color, ultimately succumb (Franck, 2008).

The yellow basins caught three species of Lepidoptera, *Lobesia botrana, Zygaena filipendulae*, and *Ptilophora plumigera*. These traps are the only ones that catch individuals from other families, such as Homoptera and Hemiptera. Among these hemipterans, we identified species from the families Pentatomidae *(Acrosternum heegeri),* Lygaeidae (*Oxycarenus* sp., *Oxycarenus lavaterae* and *Nysius* sp.) and Aphididae *(Macrosiphum euphorbiae).* Two predatory species of the family Anthocoridae were also captured: *Anthocoris nemoralis* and *Orius niger.*

The yellow basins successfully captured a diverse array of beetles belonging to the Scarabidae family, as well as Chrysomelidae represented by *Clytra quadripunctata*, Heteroptera such as *Hypocaccus* sp., Buprestidae exemplified by *Anthaxia*, and Coccinellidae. As noted by Bonneau (2008), yellow basins serve as effective entomological traps for various species of Hymenoptera, with a particular emphasis on Chrysididae, followed by Sphecidae, Vespidae, Ichneumonidae, and Apidae. Additionally, these basins attract specific beetle taxa, particularly from Buprestidae, including the genus *Anthaxia*, as well as Diptera. The yellow basins and accompanying bottles yielded a diverse range of Hymenoptera families, which encompassed Apidae, Halictidae, Vespidae, Megachilidae, Andrenidae, Sphecidae, Ichneumonidae, Formicidae, Colletidae, Psenidae, Scoliidae, Pompilidae, and Tenthredinidae. Three species classified under Ichneumonidae, namely *Gelis* sp., *Exochus* sp., and *Pimpla rufipes*, were accurately identified. The latter species are recognized as parasitoids

According to Sentenac et al. (2018), *Gelis agilis* and *Exochus* sp. have been identified as vine borer parasitoids in vineyards. These parasitoids are important for controlling populations of vine borers, which can cause significant damage to grape crops. The presence of these species in the yellow basins and bottles suggests that they may be using them as a resource for finding hosts. Further research could help determine the effectiveness of using these traps for biological control of vine borers in vineyards. It is crucial to understand the behavior and effectiveness of these parasitoids in order to develop sustainable pest management strategies in vineyards. By studying their interactions with the yellow basins and bottles, researchers can gain valuable insights into their foraging behavior and potential as biological control agents.

Within the order Neuroptera, *Chrysoperla carnea*, a species of the family Chrysopidae, has been identified. Lacewings *(Chrysoperla carnea)* can reasonably be considered as major potential beneficials in agroecosystems. These species are common, eurytopic and prey particularly small, soft-bodied arthropods (aphids, mites, etc.) (Pétremand et al., 2022). The yellow sticky trap consists of a flexible plastic sheet (about 20 x 30 cm) in bright yellow (buttercup yellow) coated with glue. This trap is suspended in the vegetation and captures a large number of insects, especially hemipterans (Kumar, 2019). Our results show that yellow sticky traps were successful in capturing the green leafhopper *(Jacobiasca lybica)* in Red Globe and Dabouki vines. The traps were installed from the first trellis line, with one trap per transect (Sarmoum et al., 2018). These results are consistent with previous research conducted by Ouabed et al. (2018), which also reported the presence of *(Jacobiasca lybica)* in the vineyards of the Mitidja region, with a total of 1,253 individuals captured using yellow sticky traps. According to Bissaad et al. (2008), the population dynamics and evolution of adults of *Jacobiasca lybica*, a pest of table grape varieties, were analyzed by capturing adults using yellow chromotrope traps during 2006, 2007 and 2008 in the western Mitidja region. The bright yellow color allows adults of green leafhoppers to be trapped by chromatic attraction.

In the study conducted by Bounaceur et al. (2018), the research was carried out in two large vineyards in the western Mitidja, with sampling conducted over an annual cycle from January to December 2005. The study revealed a significant presence of the green leafhopper, with 1,253 individuals captured. These direct examinations were supplemented by the installation of sex traps, consisting of sticky yellow shelters, with two traps per station.

3.3. Percentage frequency obtained for the orders of arthropods captured by the blue traps

The relative abundances of the orders of arthropods caught by the use of the blue traps in the two varieties (Dabouki and Red Globe) are presented in Figure 4.

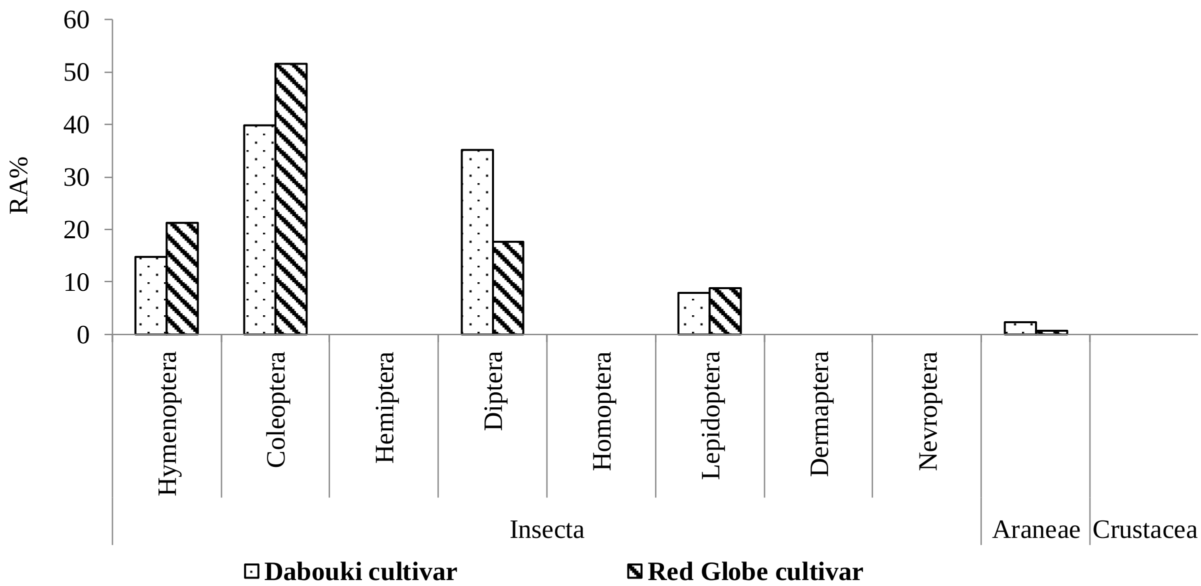

Figure 4. Relative abundance of orders captured by blue traps

The results demonstrate that in the cultivar Dabouki, the order most effectively captured by the blue traps was Coleoptera, with a capture rate of 39.8%, followed by Diptera at 35.2%, Hymenoptera at 14.8%, and Lepidoptera. Additionally, the blue traps captured Araneae.

In the Red Globe cultivar, the order most prevalent was Coleoptera, comprising 19.8% of the total catch, followed by Hymenoptera (8.2%), Diptera (6.8%), Lepidoptera (3.4%), and finally Araneae. The blue traps did not capture any Hemiptera, Homoptera, Dermaptera, Neuroptera, or crustaceans.

The blue traps, consisting of blue basins and cups filled with soapy water and suspended in the trees, effectively captured spiders, hymenoptera, and lepidoptera, including Autographa and the vine moth *(Lobesia botrana).* The blue basins were particularly effective for trapping these groups, while the blue cups were used to capture a variety of beetles, notably cetoniids. Two spiders have been recorded *Zodarion* sp and *Salticus* sp, each belonging to a different family, and they are predatory mites. These species are well-known for their role in maintaining the biological balance of agroecosystems (Michalko et al., 2019).

3.4. Percentage frequency obtained for the orders of arthropods captured by the food traps

Figure 5 illustrates the relative abundance of arthropods captured using food traps in the two varieties (Dabouki and Red Globe).

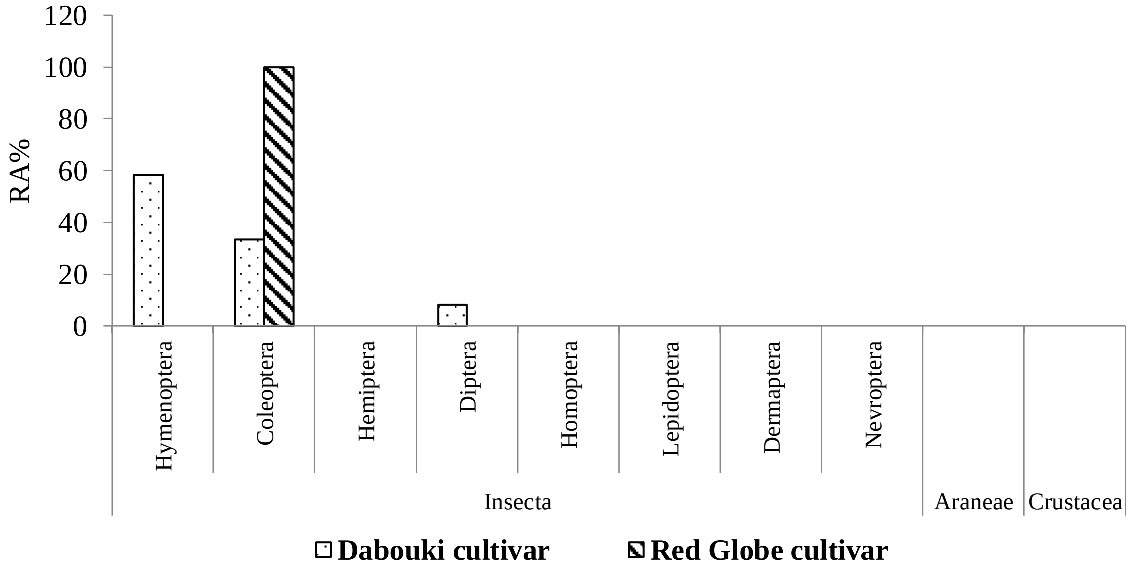

Figure 5. Relative abundance of orders captured by food traps

The results show that in cultivar Dabouki, the order most captured by food traps was Hymenoptera with 58.3%, followed by Coleoptera with 33.3% and Diptera with 8.3%. On the other hand, in the cultivar Red Globe, the order most caught was Coleoptera (100%). Food traps were the least effective in capturing arthropods, with only 14 individuals captured in total. Six species (Hymenoptera, Diptera, Coleoptera) were recorded in the Dabouki grape variety, and two species (Coleoptera) were captured in the red glob variety.

3.5. Percentage frequency obtained for the orders of arthropods captured by the pitfall traps

The relative abundances of the orders of arthropods caught by the use of the food traps in the two varieties (Dabouki and Red Globe) are presented in Figure 6.

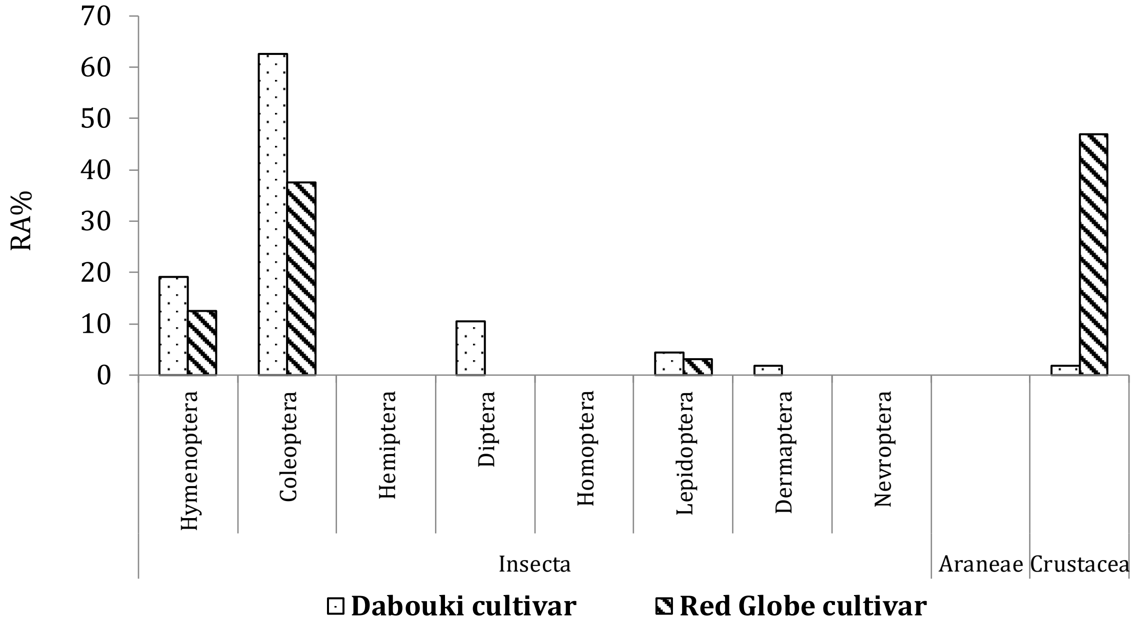

Figure 6. Relative abundance of orders captured by pitfall traps

The results demonstrate that in the Red Globe cultivar, crustaceans were the most prevalent order captured by the pitfall traps, representing 46.9% of the total catch, while beetles constituted the second-largest order, accounting for 37.5% of the catch. Moreover, the pitfall traps captured Hymenoptera (12.5%) and Lepidoptera (4.3%).

In the Dabouki cultivar, the most prevalent order was Coleoptera, representing 62.6% of the total catch. Subsequently, Hymenoptera (19.1%), Diptera (10.4%), Lepidoptera (4.3%), and finally, Dermaptera and Crustacea, which each constituted 1.7% of the total catch, were captured. In our research, pitfall traps primarily captured beetles, including Carabidae such as *Carabus morbillosus, Pseudoophonus griseus, Calosoma maderae, Harpalus distinguendus,* and *Amara* sp. Staphylinidae were also present, with *Ocypus olens*. Crustaceans captured included isopods such as *Armadillidiidae vulgaris*. Of the 124 species of carabid beetle recorded in Quebec vineyards (Vincent & Lasnier, 2016), the most common were *Chlaenius sericeus*, *Clivina fossor, Amara latior, and Harpalus herbivagus.* The most common method for sampling mobile epigean arthropods is the pitfall trap (Barber, 1931), a pot sunk into the ground that captures mobile animals. Its popularity stems from its practical advantages, it's inexpensive, easy to use, quick to set up and install, and yields large numbers of epigeic arthropods.

The pitfall trap captures the circulating fauna of epigean invertebrates, including Coleoptera, Carabidae, Silphidae, Staphylinidae, Araneids, Opilionids, Diplopods, Chilopods, Isopods, Formicidae, Dermaptera (Hohbein & Conway, 2018). The pitfall traps (Barber traps) are a very simple means of trapping all ground-moving arthropods (Siewers et al., 2014; Bertoia et al., 2023).

This form of trapping is the most employed approach in collecting the insects that travel to the soil surface as well as in capturing the flying insects attracted by dampness (Blondel, 1979). Other beetles were caught in the pitfall traps, including Silphidae such *as Silpha tristis*, weevils of the genera *Lixus* and *Larinus*, two species of Histeridae, tenebrionids such as *Alphitobius diaperinus, Heliotaurus ruficollis*, and *Pachychila germari*, and ladybirds such as *Coccinella septempunctata*.

Dermapterans were also collected, including *Forficula auricularia* from the family Forficulidae and *Anisolabis maritima* from the family Carcinophoridae. These observations confirm the effectiveness of Barber traps in capturing epigeic arthropods and highlight the diversity of taxonomic groups captured. The latter is a highly polyphagous predator capable of consuming the larvae and pupae of *Lobesia botrana* on grape clusters (Arvenseq et al., 1988).

Our results show that the traps captured hymenopterans of the family Formicidae. Four species of ants were identified, *Messor barbarus*, *Tapinoma nigerrimum*, *Cataglyphis viatica*, and *Cataglyphis savignyi*. The pitfall traps captured lepidopterans of the family Pieridae, such as *Pieris brassicae*, and of the family Nymphalidae, with *Vanessa cardui*. They also captured dipterans, including flies of the family Calliphoridae, such as *Calliphora vicina,* and the family Muscidae, with *Musca domestica.*

4. Conclusion

The study of arthropodofauna dynamics in the vineyards of Dabouki and Red Globe grape varieties revealed significant diversity, particularly among insects. The different trapping techniques demonstrated that yellow traps were the most effective in capturing a wide range of species, while Barber pots proved particularly effective for soil-dwelling species. Blue traps also played an important role, whereas bait traps, designed to target specific species, captured a smaller number of individuals. These results underscore the importance of selecting and combining trapping methods to effectively manage arthropod biodiversity in vineyards. Overall, this research has both scientific and practical implications, supporting more sustainable and efficient vineyard management while promoting biodiversity as a natural asset for agricultural systems.

Acknowledgments

I wish to express my gratitude to Mr. Hasnaoui and the DSA team for providing the vineyards necessary for sampling. I am profoundly thankful to my father Mr. Benmokhtar Azzedine due to his continual support and encouragement, particularly in the field.

Author’s declaration and contribution

The authors declare that they have no conflicts of interest. BR, a PhD student in agronomy, conducted the field sampling of arthropods, analyzed the data, and drafted the manuscript. BFZ, a professor of agronomy, was responsible for data processing and manuscript revision. MF, a professor of agronomy, contributed to the identification of species. BF, a professor of agronomy, oversaw the effort and finished the article. The final draft of the work has been reviewed and approved by all writers.

References

Arvenseq, S., Blanc, M. & Reboulet, J.N. (1988). Les organismes auxiliaires en vigne [Auxiliary organisms in vineyards]. *Phytoma, La défense des végétaux*, *502*, 44-47. Direct Link.

Barber, H. S. (1931). Traps for cave-inhabiting insects. *Journal of the Elisha Mitchell Scientific Society*, *46*(2), 259-266. Direct Link.

Bertoia, A., Murray, T., Robertson, B.C. & Monks, J.M. (2023). Pitfall trapping outperforms other methods for surveying ground-dwelling large-bodied alpine invertebrates. *Journal of Insect Conservation*, *27*, 679–692. CrossRef

Bissaad, F. Z., Razi, S., & Bounaceur, F. (2018). Influence of grapevine vigor on the dynamic and the installation of the invasive pest *Jacobiasca lybica* in Mitidja, Algeria. *Tunisian Journal of Plant Protection, 13* (1), 139-146. Direct Link.

Blondel, J. (1979). Biogéographie et écologie [Biogeography and ecology]. Masson. Direct Link.

Bonneau, P. (2008). Mes pièges à insectes [My insect traps]. *Le monde des insectes (forum communautaire francophone des insectes et autres arthropodes [The World of Insects (Francophone Community Forum on Insects and Other Arthropods).* Direct Link.

Bounaceur, F., Bissaad, F. Z., & Doumandji-mitiche, B. (2018). Etude de la biocénose viticole du nord algérien [Study of the viticultural biocenosis of northern Algeria]. *Journal Scientifique Libanais*, *19*(2), 150-176. Direct Link.

De Groote, H. (2022). Economic analysis of pest problems in agriculture and food chains in Africa. Current Opinion in Insect Science, 54, 100969. CrossRef

Deguine, J-P, Aubertot, J-N., Flor, R.J., Lescourret, F., Wyckhuys, K. A.G., & Ratnadass, A. (2021). Integrated pest management: Good intentions, hard realities. A review. *Agronomy for Sustainable Development, 41* (8), 1-35. CrossRef

Faurie, C., Ferra, C., & Medori, P. (2011). *Ecologie : approche scientifique et pratique* [Ecology: scientific and practical approach]. Lavoisier. Direct Link.

Franck, A. (2008). Capture, conditionnement, expédition, mise en collection des insectes et acariens en vue de leur identification [Capture, packaging, shipping, and collection of insects and mites for identification purposes]. CIRAD. Direct Link.

Guermah, D. (2019). Bioécologie du carpocapse du pommier *Cydia pomonella* L. (Lepidoptera: Tortricidae) et inventaire de la faune arthropodologique dans des vergers de pommier traités et écologique dans la région de Tizi-Ouzou (Sidi Nâamane et Draa Ben Khedda) [Bioecology of the apple codling moth *Cydia pomonella* L. (Lepidoptera: Tortricidae) and inventory of arthropod fauna in treated and ecological apple orchards in the Tizi-Ouzou region (Sidi Nâamane and Draa Ben Khedda)]. Thèse de doctorat, Universite Mouloud Mammeri, Algérie [PhD thesies, university Mouloud Mammeri, Algeria]. Direct Link.

Hohbein, R.R., & Conway, C.J. (2018). Pitfall Traps: A review of methods for estimating arthropod abundance. *Wildlife Society Bulletin, 42*(4), 1-10. CrossRef

Kumar, R., Kranthi, S., Monga, D., Kumar, S., Sain, S.K., & Chaudhary A. (2019). Evaluation of moving yellow sticky traps for monitoring and management of whitefly, *Bemisia tabaci* infesting cotton. *Indian Journal of Agricultural Sciences*, *89* (8), 1245–1250. Direct Link.

Lozano, D.P., Bosquee, E., Lopes, T., Chen, J., Cheng Deng, F.A., Yong, L., Fang-Qiang, Z., Haubruge, E., Bragard, C., & Francis, F. (2013). Evaluation de la diversité de l'entomofaune en culture maraichères dans l'est de la chine [Evaluation of the diversity of entomofauna in vegetable crops in eastern China]. *Entomologie faunestique –Faunistic Entomology, 66*, 27-37. Direct Link.

Michalko, R., Pekár, S., & Entling, M.H. (2019). An updated perspective on spiders as generalist predators in biological control. *Oecologia*, *189*(1), 21-36. CrossRef

Ouabed, A., Demnati, F., & Bounaceur, F. (2018). Potentialités des auxiliaires en milieux viticoles et perspectives d'une lutte biologique par conservation [Potential of Auxiliaries in Viticultural Environments and Perspectives of Biological Control through Conservation]. *Revue Ecologie-Environnement*, *15*, 50-58. Direct Link.

Pétremand, G., Ali, M., Attias, D., Badano, D., Bessat, M., Cabezas, V., … & Castella, E. (2022). Les insectes auxiliaires dans les paysages agricoles: apports faunistiques, écologiques et fonctionnels de récentes études dans le canton de Genève (Suisse) [Auxiliary insects in agricultural landscapes: faunistic, ecological, and functional contributions from recent studies in the canton of Geneva (Suisse)]. *Base, 26*(4), *224-240.* CrossRef

Ramade, F. (2020). Ecologie fondamentale [Fondamental ecology]. Dunod. Direct Link.

Sarmoum, R., Biche, M., & Djazouli, Z. E. (2018). Inventaire des espèces folivores de la vigne *Vitis vinifera* dans la Mitidja occidentale. Effet du cépage sur la structuration des réseaux trophiques [Inventory of folivorous species of the vine *Vitis vinifera* in western Mitidja. Effect of grape variety on the structuring of trophic networks]. *Revue Agrobiologia*, *8*(2), 1027-1037. Direct Link.

Sentenac, G., Rusch, A., Kreiter, S., Bouvier, J. C., Thiery, J., Delbac, L., ... & de Bourgogne, B. I. D. V. (2018). Biodiversité fonctionnelle : effet de l'environnement paysager d'une parcelle de vigne sur la régulation de ses ravageurs (Biocontrol) [Functional Biodiversity: impacts of a vineyard's landscape on its ravager's regulation (Biocontrol). *Innovations Agronomiques, 63*, 139–161. Direct Link.

Siewers, J., Schirmel, J., & Buchholz, S. (2014). The efficiency of pitfall traps as a method of sampling epigeal arthropods in litter rich forest habitats. *European Journal of Entomology, 111*(1), 69–74. CrossRef

Southwood, T.R.E., & Henderson, P.A. (2000). *Ecological Methods*. (3rd Edition). Wiley-Blackwell. Direct Link.

Tartanus, M., & Malusà E., (2024). Drivers of and barriers to the implementation of integrated pest management in horticultural crops. *Horticulturae*, *10*, 1-3. CrossRef

Vincent, C., & Lasnier, J. (2016). Les arthropodes des vignobles québécois [The arthropodes of Québécois vignobles]. *Phytoma*, *697*, 45-48. Direct Link.

Welti, E. A., Joern, A., Ellison, A. M., Lightfoot, D. C., Record, S., Rodenhouse, N., Stanley, E. H. & Kaspari, M. (2021). Studies of insect temporal trends must account for the complex sampling histories inherent to many long-term monitoring efforts. *Nature Ecology & Evolution*, *5(*5), 589-591. CrossRef