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Arthropods Diversity Associated to Almond Cultivation (*Prunus dulcis* L.) in Tizi-Ouzou Region

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ABSTRACT

Background: This study deals with the arthropods biodiversity restricted to almond tree plot located in Tafoughalt (Tizi-Ouzou, Algeria). The study of their diet makes it possible to identify the trophic categories in order to carry out a reasoned fight if necessary against harmful species.

Methods: To do this, 03 capture methods (sweep net, Barber pots and colored traps) was used. The work is carried out from September 2021 to August 2022.

Result: The captures allowed us to identify 108 species of arthropods divided into 05 classes (Arachnida, Crustacea, Myriapoda, Enthognata and Insecta), 16 orders and 54 families.The Coleoptera and Homoptera are the most important of which were with a relative frequency of 54.49% and 25.84% respectively using the sweep net. Coleoptera, Hymenoptera and Diptera are abundant in Barber pots, with a relative frequency equal to 29.38%; 25.05% and 19.36% respectively. Species belonging to the order Homoptera and Hymenoptera are the most counted in aerial yellow traps with a frequency of 26.17% and 25.5%, followed by Diptera and Coleoptera with 20.13% and 14.54%. The Shannon diversity index varied according to the sampling method; the values ranged between 3.38 bits for coloured traps, 3.34 bits for the Barber pots and 2.27 bits for the sweep net. According to the trophic status, the highest indices were recorded for phytophagous with 55% captured by sweep net, 45.07% for coloured traps and 39.68% for the Barber pots.

Key words: Almond tree, Arthropods, Diversity, Tizi-Ouzou, Trophic regime.

INTRODUCTION

Cultivated environments, due to their floristic richness, provide the habitat and the various food resources necessary for a large number of species of arthropods which can be phytophagous, predators and parasites, as well as microbial pathogens which act as natural enemies, agricultural pests, constituting means of biological control in agrosystems. Kennedy (2003); Lozano *et al.* (2013); Zappala *et al.* (2012) recall that among the functional group predatory insects and parasitoids play an essential role in the natural control of insect pest populations. The preservation of biodiversity represents, in addition to the undeniable ecological challenges, an economic challenge for society. Knowledge of arthropod species in agrosystems has various interests, particularly in the biological control of harmful species. Indeed, Choudourou *et al.* (2012) state that the preliminary step to successful crop protection is knowledge of the pests. Pollination is another important ecosystem service provided by biodiversity. Klein *et al.* (2007) estimated that 75% of plant species of global importance for food production depend on animal pollination, mainly by insects. Agricultural biodiversity is therefore of paramount importance in the functioning of agroecosystems (Tscharntke *et al*. 2005), Also, arthropods constitute a good biological indicator and they form an essential element of the foodavailability for many animal species (Souttou *et al*., 2011). Arthropods have been recognized as effective indicators of ecosystem function and recommended for use in conservation planning (Finnamore, 1996) and many researchers have assessed habitat quality and measured habitat differences using arthropods (Gibb and Hochuli, 2002). This title deserves to be not only preserved but also integrated as a major element of sustainable agriculture. It is in this context that this study was carried out. Our choice fell on the cultivation of the almond tree, the surface of the new plantations of which is quite large in the Kabylia region and no study is carried on it before. Despite the advantages and economic importance that this crop offers, in addition to the different constraints, are affected by different

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organisms, whether useful or harmful. The current study aims to describe the composition of the arthropods related to the cultivation of almond in the region of study. For this we considered it useful to make an inventory and classify the arthropods present in this culture. Also define the trophic diet of the species and consider, if necessary, a reasoned fight against pests by a method that is more respectful of the environment, human and animal health.

MATERIALS AND METHODS

The study was carried out in a plot of almond tree (*Prunus dulci* L.) in the region of Tafoughalt at the level of Ait Yahia Moussa located 40 km south of the chief town of the Tizi-Ouzou department (North of Algeria) at 36°38′28″ North latitude and 3°53′18″ East longitude and at 500m of altitude. The soil is clayey-loamy with a temperate sub-humid climate.

In order to carry out this work and in order to know which arthropods live in the almond plot, 18 outings were carried out from September 2021 to May 2022 at the rate of 2 outings per month. Three sampling methods, Barber pots, attractive traps or coloured traps and sweep net, were used to realize a complete arthropods biodiversity inventory.

The sweep net is used perpendicular to the ground while maintaining it by back and forth movements, the maneuvers are rapid and violent so that the insects caught by the impact fall into the pocket; 10 strokes of the sweep net correspond to a single sample (10 samples), Nine pots are placed at the level of the plot, these pots consist of simple plastic containers, about 10 cm deep and these are buried at the foot of the trees, vertically so that the opening is flush soil, with the earth packed around it, in order to avoid the barrier effect for small species (Nageleisen and Bouget, 2009). The traps are filled to 2/3 of their capacity with water added with preservative liquid. The pots are installed in a quadrat in three rows throughout the plot, with three traps per row of about ten trees, so that there is no interaction between them (Benkhelil, 1992). The pots are visited every 15 days, the visit allows the harvest of the trapped arthropods and to replace the water contained in the Barber pots for the next captures.The colored traps are plastic containers, yellow in color, filled to 3/4 of their content with water to which a preservative has been added. We used in each plot 9 traps of yellow color, 15 cm in diameter and 15 cm in depth, placed at a height of 1.5 m and fixed with iron wire to the branches of the trees. These traps are placed in a quadrat. These colored traps have a double attraction on the one hand, due to their color and on the other hand to the presence of water (Roth et Berre, 1963). This method makes it possible to capture flying insects, frequenting the foliage of trees.The captured invertebrates were preserved in glass bottles with a plastic stopper. The bottles were twothirds filled with 70° alcohol and labelled with the number of the trap, the date and the place of capture. The samples were sorted in the laboratory.

The identification of the listed arthropods is carried out thanks to the different identification keys that we have used (Seguy, 1923, 1924); (Perrier, 1927, 1932, 1961); (Pihan, 1986); (Chinery, 1988); (Delvare and Aberlenic, 1989); the results are confirmed by Doctor Guermah Dyhia, lecturer and teacher at Mouloud Mammeri University in Tizi-Ouzou (Algeria). After identifying, their trophic regimes are determined through a bibliographic search.

The sampling quality and total species richness (S) are calculated for each sampling method used. The relative abundance (RA %) was calculated for each species (percentage of the species (Ni) in the total number of all species combined (N) (Magurran, 2004).

$$Q = \frac{a}{N}$$

Where,

a: Refers to the number of species of frequency 1, *i.e*. seen only once in a survey during the entire period considered.

N: Total number of readings.

The Shannon index (Dajoz, 1971) was calculated to assess species diversity on each sampling method. The Evenness Index (E) was also calculated (ratio between the Shannon index and the maximum diversity (H′max) (Ramade, 2003).

$$H' = - \Sigma Pi Log_2 Pi$$

RESULTS AND DISCUSSION

The inventory of arthropods captured by the three sampling methods enabled the capture of the species presented in the following table:

The inventory carried out in the almond plot allowed us to capture 108 species distributed over 55 families, 16 orders and 05 animal classes which are Arachnida, Crustacea, Myriapoda, Enthognata and Insecta.

The recorded results are evaluated by the quality of sampling and then exploited by the ecological indices of composition and structure (Table 1).

Exploitation of the results by the quality of sampling by the use of different methods at the level of the different study plot

The values of the sampling quality of the species captured using the different sampling methods at the level of the study greenhouse are presented in the table.

The values of the species captured only once and in a single specimen by the different sampling methods at the level of the study plot are between 0.05 and 0.55, which indicates that the sampling quality is considered very good because the values approach zero (Table 2).

Exploitation of the results by the ecological indices of composition

The results obtained are exploited using ecological indices of composition, namely total richness and relative abundance.

Table 1: General table representative of the species captured by the different sampling techniques at the level of the almond plot.

Classes	Orders	Familis	species	Sweep net	Barber pot	Colored traps	Ni
Enthognate	Collembola	Entomobreidae	*Entomobrya nivalis*	-	+	-	8
Crustacea	Isopoda	Armadillidae	*Armadillidium vulgare*	-	+	-	13
		Glomeridae	*Glomeris* sp.	-	+	-	6
Myriapoda	Scutigeromorpha	Scutigeridae	*Scutigera coleoptrata*	-	+	-	4
Arachnida	Opiliona	Phalangiidae	*Phalangium opilio*	-	+	-	4
		Araneidae	*Araniella* sp.	-	-	+	5
		Lycosidae	*Lycosa narbonensis*	+	+	-	19
		Thomisidae	*Synema globosum*	+	+	+	10
Insecta	Coleoptera	Carabidae	*Bembidion atripes*	-	+	-	18
			Cicindella campestris	-	+	-	2
			Harpalus fulvus	+	+	-	14
			Harpalu slatus	-	+	-	93
			Macrothorax morbillosus	-	+	-	9
		Buprestidae	*Anthaxia bicolor*	-	+	+	6
			Anthaxia dimidiata	-	+	-	5
			Buprestidae sp.	+	-	+	17
		Histeridae	*Hister* sp.	-	+	-	5
		Scarabaedae	*Rhiso tragus aestivus*	-	+	-	4
		Drilidae	*Drillus flavescens*	+	+	-	17
		Cleridae	*Trichodes alveatrius*	-	+	+	9
		Coccinelidae	*Adalia bipunctata*	+	-	+	3
			Coccinella algerica	-	+	+	13
			Hippodamia variegata	-	+	+	17
			Harmonia axyridis	-	-	+	4
			The avigintiduopunctata	-	+	-	8
		Cetoniidae	*Oxythyrea fumesta*	-	+	-	11
			Tropinota squalida	-	-	+	4
			Cetonia aurata	-	-	+	2
		Tenebrionidae	*Pimelia grandis*	+	+	-	17
			Pachychilaservellei	+	-	-	7
		Elateridae	*Elateridae* sp.	-	-	+	5
		Chrysomelidae	*Chrysolina americana.*	-	-	+	3
	Diptera	Calliphoridae	*Calliphora vicina*	-	+	+	5
			Lacilia caesar	-	-	+	9
			Calliphora vomitoria	-	-	+	4
			Calliphora sp.	-	+	+	13
			Lucilia sericata	-	+	+	19
		Tipulidae	*Tipulao leacera*	-	+	+	15
			Tipu lalateralis	-	-	+	1
			Tipula vernalis	-	-	+	2
		Syrphidae	*Eristalinus taeniops*	-	-	+	4
			Syrphus ribesii	+	+	+	11
			Platycheirus fulviventris	-	-	+	6
			Episyrphus balteatus	-	-	+	3
			Syrphus sp 1.	-	-	+	3
		Chloropidae	*Thaumatomyia notata*	-	+	+	2
		Empididae	*Hilara maura*	-	+	-	3
		Muscidae	*Musca domestica*	-	+	+	27
			Musca sp.	-	-	+	10
		Drosophilidae	*Drosophila funebris*	-	-	+	7

Table 1: Continue...

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	Culicidae	*Culex pipiens*	-	+	+	31
		Anopheles sp.	-	+	-	3
	Psycodidae	*Phlebotominae* sp.	-	+	-	1
Hymenoptera	Formicidae	*Componotus lateralis*	-	+	-	11
		Cataglyphis cursor	-	+	+	19
		Cataglyphis viaticus	-	+	-	13
		Cataglyphis vagus	-	+	+	8
		Crymatogaster sp.	-	+	-	9
		Messor structor	-	-	+	2
		Messorbar barus	+	+	+	42
		Pheidole pallidula	-	+	+	37
	Andrenidae	*Andrena labiata*	-	+	-	7
		Andrena thoracica	-	+	+	17
		Andrena flavipes	-	-	+	12
		Andrena sp.	-	-	+	3
		Panurgus calcaratus	-	-	+	11
	Halictidae	*Lasioglossum calceatum*	+	-	+	5
	Pteromalidae	*Pteromalus disparus*	-	-	+	4
	Gateruptiidae	*Gateruptiumjaculator*	-	-	+	3
	Chrysididae	*Chrysis ignita*	-	-	+	11
	Apidae	*Apis mellifera*	+	+	+	57
		Bombus terrestris	-	-	+	9
	Vespidae	*Poliste gallicus*	-	-	+	3
		Vespula germanica	-	-	+	9
Lepidoptera	Nymphalidae	*Boloria dia*	-	-	+	9
	Pieridae	*Pieris brassicae*	+	-	-	5
		Pieris napi	-	-	+	2
	Sphingidae	*Anara* sp.	-	-	+	11
Heteroptera	Lygaeidae	*Nysius* sp.	+	+	+	12
	Pentatomidae	*Dolycoris baccarum*	-	+	+	3
		Nezara viridula	+	+	+	5
	Reduvidae	*Reduvius* sp.	-	+	-	9
		Reduvius personatus	-	+	-	9
	Miridae	*Lygus rugulipennis*	-	-	+	3
	Pyrrhocoridae	*Pyrrhocoris apertus*	-	+	-	7
	Anthocoridae	*Orius niger*	-	-	+	6
	Triatomidae	*Triatoma* sp.	-	+	-	2
Mantodea	Mantidae	*Mentis religiosa*	+	-	+	9
Homoptera	Cicadellidae	*Amblycellus curtisii*	-	-	+	10
		Cicadella viridis	+	+	+	13
		Cicadella sp.	-	-	+	2
	Aphididae	*Aphis citricola*	—	+	+	45
		Aphis fabae	+	+	+	35
		Aphis gossipy	+	+	+	19
		Dysaphis plantaginea	+	+	+	15
		Myzus percicae	-	-	+	10
		Toxoptera aurantii	-	-	+	27
Orthoptera	Acrididae	*Calliptanusitalicus*	+	+	+	7
		Dociostaurus maroccanus	-	+	-	6
		Aiolopus thallasimus	-	+	-	2

Table 1: Continue...

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		Gryllidae	*Grillus campestris*	-	-	+	4
			Gryllus bimaculatus	-	+	-	1
			Gryllus sp.	-	+	-	1
		Tetigoniidae	*Ephippigera ephippigera*	-	+	-	3
	Neuroptera	Chrysopidae	*Chrysoperla carnea*	-	-	+	9
	Dermaptera	Forficulidae	*Forficula auricularia*	-	+	-	6
			Forficula sp,	-	+	-	2
	Thysanoptera	Thripidae	*Thrips palmi*	-	+	-	3
5	16	55	108	21	65	69	1142

Table 2: Sampling quality values of the species captured using the different capture methods in the study plot.

Trap type	Sweep net	Barber pot	Colored traps
Samplingquality (Q)	0.05	0.55	0.33

Table 3: Total species richness captured by the different sampling methods at the study plot.

Trap type	Sweep net	Barber pot	Colored traps
Totalrichness S	21	65	69

Total richness of arthropod species captured using the three sampling methods at the study plot

The total richness of species captured is expressed in the Table 3.

Using the sweep net, the total richness is 21 species. Barber pots or land traps captured a total of 65 species. A total richness of 69 species is harvested with colored or aerial traps.

Percentage frequencies or relative abundances (AR %) applied to the orders of arthropods identified at the level of the study plot by the use of three sampling methods

The relative abundances of invertebrates harvested at the level of the study greenhouse by the application of the three capture methods (sweep net, colored traps and Barber pot) vary from one method to another. The dominance of some species over others depends on the capture method used.

The order best represented by the use of the sweep net is that of Coleoptera and Homoptera with a relative frequency of 54.49% and 25.84% respectively, followed by Spiders and Heteroptera with respectively 7.86% and 6.17%. Mantoptera and Orthoptera are present with a relative frequency of only 2.8%. Coleoptera, Hymenoptera and Diptera are abundant through the use of Barber pots, with a relative frequency equal to 29.38%; 25.05% and 19.36% respectively, followed by Heteroptera and Isoptera with a relative frequency equal to 6.83% and 4.33%. The scutigeromorpha and the Thysanoptera are represented with a low percentage equal to 0.91% and 0.68%. Species belonging to the order Homoptera and Hymenoptera are the most counted in aerial yellow traps. These orders present a relative frequency of 26.17% and 25.5%, followed by Diptera and Coleoptera with a percentage of 20.13% and 14.54%. Mantopteraare poorly represented with only 0.45% (Fig 1).

Diet of the various arthropological groups

Several diet types of arthropod species are determined, which are Predators, Phytophageous, pollinators, Detritivores, Hamatophageous, Necrophageous and Omniphageous (Fig 2).

The group best represented by the use of the sweep net is that of phytophagous and predators with 55% and 32% respectively. Next come pollinators, with 9%. Omnivores account for a low rate equal to 4% of all catches. Phytophagous and predators groups are the most abundant through the use of aerial yellow traps, with a relative frequency equal to 39% and 19% respectively. Next come omnivores with 11% and pollinators; scavengers; hematophagous and necrophages with 5% each (Fig 2).

The phytophaga group is the most accounted for in terrestrial trappings or Barber pots with a relative frequency equal to 45%. Predators follow with 23%. Pollinators, omnivores and scavengers are estimated at 13%, 7%, 7% and 5.55% respectively. Finally, parasitoids and haematophagous account for low rates with 4% and 1% of all catches (Fig 2).

Exploitation of the results by ecological indices of structure for the sampled species

The results obtained are exploited using ecological indices of structure; see Shannon's diversity and equitability indices.

The results relating the indices of Shannon's diversity (H′), maximum diversity (H'_{max}) and evenness (E) applied to the arthropod species sampled by the different types of traps at the plot level study are shown in the Fig 3.

The values of the Shannon's diversity index are quite high at the level of the almond plot, H′= 2.27 bits for the sweep net, H′= 3.38 bits for the yellow traps and H′= 3.34 bits for the pots Barber. The maximum diversity is equal to H'_{max}= 4.41 bits for the sweep net, H_{max}= 6.14 bits for the yellow traps and H'_{max}= 6.05 bits for the Barber pots (Fig 4).

The study of the arthropodological fauna on almond cultivation in the rural region of Tafoughalt (Tizi-Ouzou)

made it possible to list 108 species distributed in 54 families, belonging to 16 orders and 05 systematic classes using three techniques of capture. The results obtained show that the best represented class is that of insects with a percentage of 95.78%, In the same vein, Souttou *et al.* (2006) captured 70 species of arthropods, belonging to 3 classes, including that of insects, represented by 69 species, divided into 36 families of 8 orders using the Barber pot technique in a palm grove in OuedSidiZarzour (Biskra) 90.69% and 59.49% of insects are noted by Hadjoudj *et al.* (2018) in dunesand palm groves respectively. The realization of an inventory of arthropods in a palm grove shows that the class of insects is the most populated by 46 species, or 95.84% of the total, followed by crustaceans and arachnids by one species and a percentage of 2.08% each (Achoura and Belhamra, 2010). Fekkoun *et al.* (2011), during a study on the effect of climatic conditions on the entomomacrofauna of the *Citrus* grove in the plain of Mitidja, report that the class of insects is the most abundant with 88.4%, followed by arachnids and crustaceans with 5.6% and 4.5% respectively. The total richness of the species captured is very variable, it depends on the type of trap used, by using the sweep net it is 21 species, 65 species for the Barber pots and 69 for the colored traps. Frah *et al.* (2015) during their study on the arthropodological fauna in Sefiane (Batna) estimated the total richness at 71 species

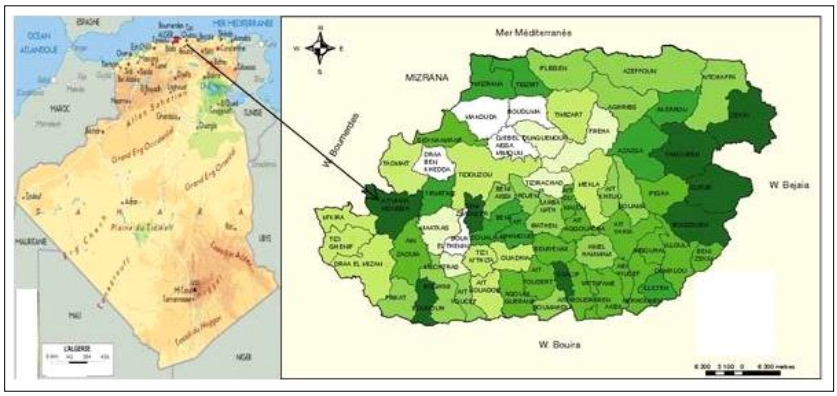

Fig 1: Geographic situation of study area (Google maps, 2024).

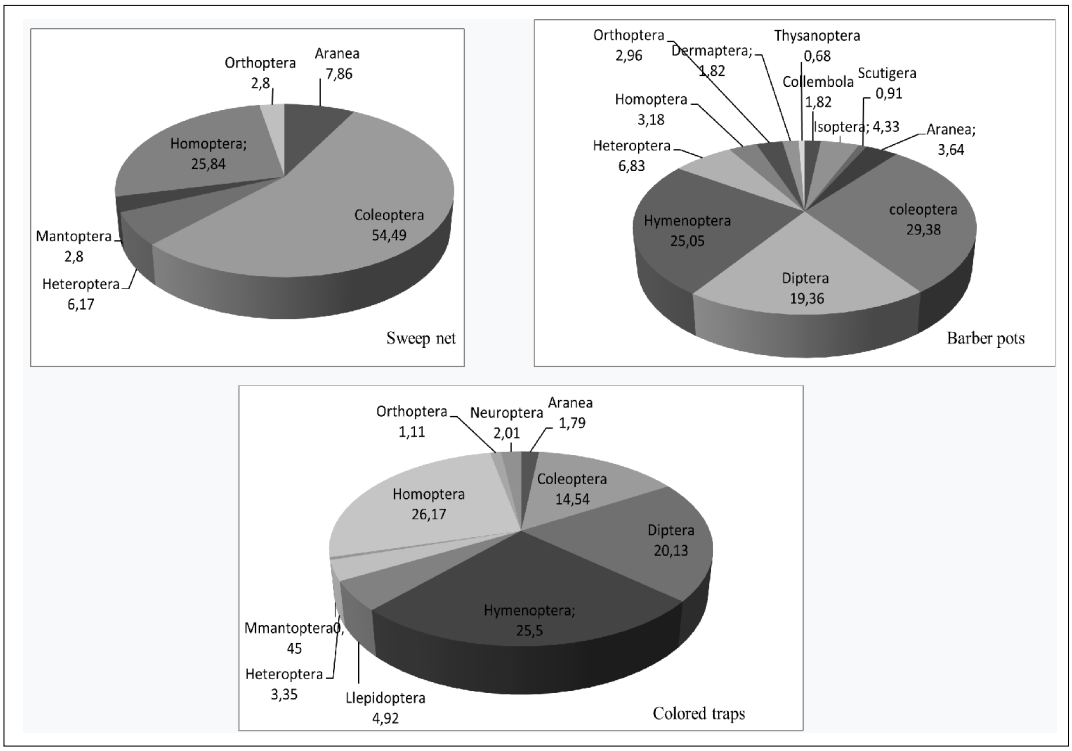

Fig 2: Centesimal frequencies of arthropod orders captured in the study plot using different sampling techniques.

using the Barber pots, 63 for the colored traps and 54 using the sweep net. The Barber pots and the yellow traps respectively, which indicates that the sampling quality is judged to be very good because the values are approaching zero. Along the same lines, Oudjiane *et al.* (2014) estimated the quality of sampling at Q = 0.55 in the Tigzirt region. Ounis *et al.* (2014) during an estimation of soil biodiversity in an apricot plot reported that the Coleoptera order dominates with a percentage of 46.67%. Guermah *et al*. (2021) noted that the order of beetles is best represented with an abundance of 25.69% by the use of Barber pots, by the use of the sweep net the beetles dominate with a percentage frequency of 27.68%, the yellow plates attract diptera with a frequency equal to 42.31. Beddiaf *et al.* (2014) during a study carried out on the arthropodological fauna in the Djanet region, report that the Hymenoptera order is the best represented with a relative abundance equal to 78.6%.

Depending on the diets, we noted 5 groups, the most represented phytophagous with 44.23%; followed by predators with 26.92%, pollinators with 8.97%, omnivores with 8.33% and necrophages with 5.12%, finally parasites

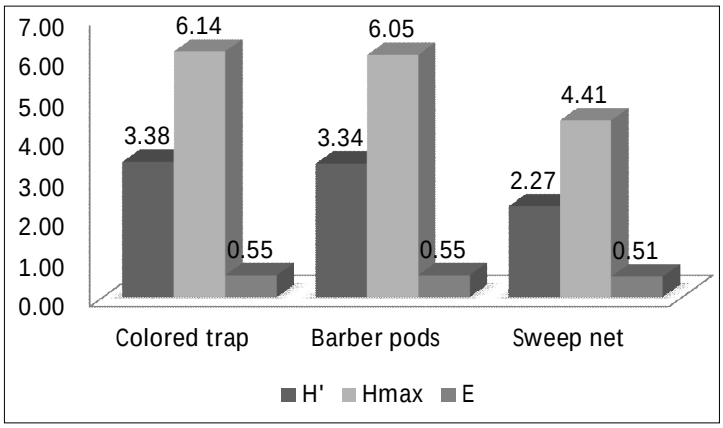

Fig 3: Shannon's diversity H', Eveness (E) and H'_{max}values of arthropods species captured using different sampling methods at the study plot level.

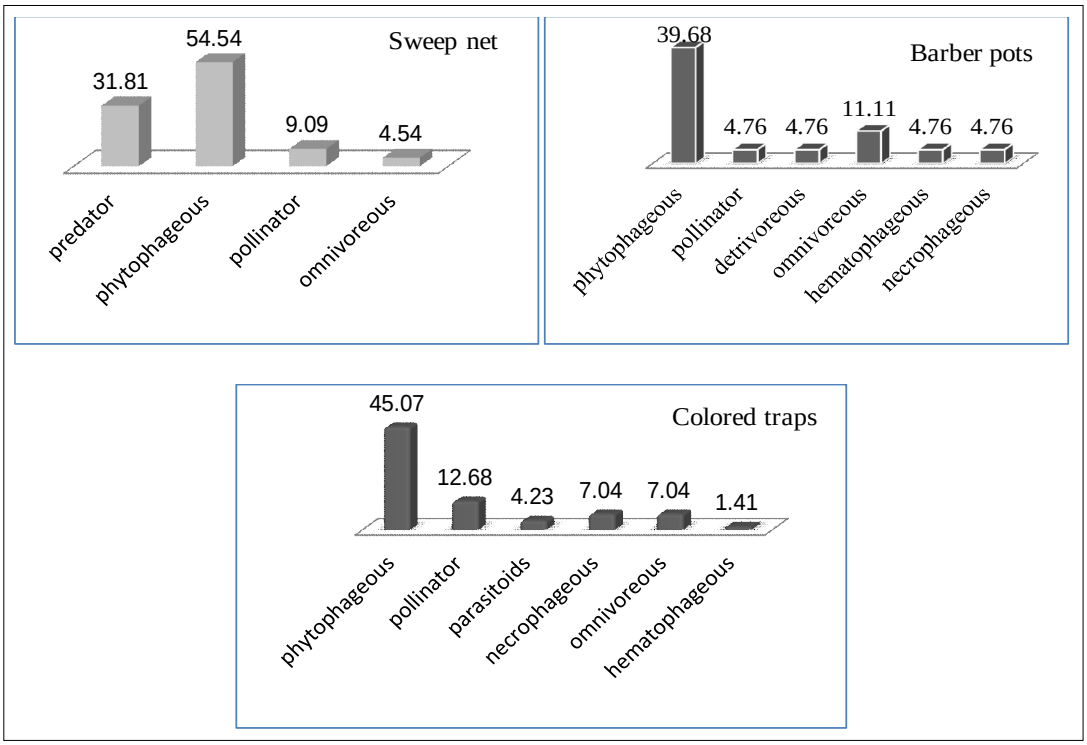

Fig 4 Classification of species according to trophic regime.

and polyphages with a rate of 02.08% each. Our results corroborate those of Lestari *et al.* (2020) who notedthe abundance of phytophagous on different rice varieties, Achoura and Belhamra (2010) who noted five groups whose phytophagous are the best represented with 56.25%. They are followed by predators with 20.83%, saprophages with 18.78% and finally parasites and polyphages with 2.08%. Mahdjane (2013) obtained a frequency of 57.4% for phytophagous, followed by predators with a value of 20.63% and polyphagous with 18.87%, in his inventory on plum insects in the area of Tadmait, Tizi-Ouzou. Similarly Guermah *et al.* (2021), who noted a percentage of 53% phytophagous on *Opuntiaficus indica*. We also note the presence of coprophages, necrophages, bioindicators and hematophages in limited numbers. According to Dajoz (1975), coprophages live on animal excrement and help structure nitrogen in the soil. Values of the Shannon diversity index are quite high at the level of the study plot, they are H′= 2.27 bits for the sweep net, H′= 3.38 bits for the aerial colored traps and H′= 3.34 bits for ground traps or Barber pots. Our results are close to those obtained by Guermah *et al.* (2022) in a plot of *Pyruscommunis*. The variations in the values of the Shannon index are explained by N'zala *et al.* (1997) who pointed out that if the living conditions in a given environment are favourable, many species are captured and each of them is represented by a small number of individuals. In the case where the conditions are unfavorable, a small number of species is noted, each of which is represented by a large number of individuals. Barbault (1981) adds that the quantity of plant species available affects the richness of the animal procession. Our results are similar to those of Guermah and Medjdoub-Bensaad (2016) who report a Shannon diversity equal to H′=4.31 bits with a maximum diversity equal to H_{max} = 6.64 bits applied to the arthropods sampled by the use of the sweep net on a plot of apple tree in the Tizi-Ouzou region. Yasri *et al.* (2006) in a study on arthropods in the Djelfa region, mention a diversity of 4.63 bits. Using the Barber pot technique for the study of arthropod biodiversity in an olive plot in Sefiane (Batna), Frah *et al.* (2015) report a diversity value is H=4.7 bits, using Barber pots; H′ = 4.6 bits, using the colored traps and H′ = 5.2 bits, using the sweep net. Mezani *et al.* (2016) evaluated Shannon diversity for Barber pots and colored traps at H′= 4.95 and H′= 4.6 respectively on a bean crop in the Tizi-Ouzou region. The values of the equitability obtained for each type of trap in the study plot vary from E=0.51 for the sweep net, E= 0.55 for the aerial colored traps as well as the Barber pots, these values tend towards 1, which reflects a balance between the species living in the study plot. Our results are close to those of Belmadani *et al*. (2014) in a study on the distribution of arthropods in a pear orchard in Tadmait obtained the value of E=0.3. Ounis *et al.* (2014) found an evenness ranging from 0.12 to 0.47. Frah *et al.* (2015) during a study on the arthropodological fauna in an olive plot evaluated the evenness at 0.77 using Barber pots and colored traps and 0.90 using the sweep net. Guermah and Medjdoub-Bensaad (2016) found an evenness of 0.65 in an apple plot.

CONCLUSION

The first study of an inventory of arthropods carried out in the almond tree plot made it possible to estimate a significant diversity which is linked to the fact that the plot is not treated with chemicals and by its location bordering other crops. The diversity of phytophagous is associated with the presence of trophic sources present in the agrosystem. Also note the presence of some passing pterygote species captured in aerial traps subservient to other neighboring crops.

Conflict of interest

All authors declared that there is no conflict of interest.

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