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OBSERVATIONS ON ARTHROPODS EXISTING IN SOME ARONIA PLANTATIONS IN THE NE AREA OF ROMANIA

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Abstract

Black chokeberry (Aronia melanocarpa L.) is a fruit-bearing shrub that has come to the attention of growers due to the content of antioxidants and vitamins in the fruit. Being a perennial crop, it provides stable habitats for both useful and harmful entomofauna. The aim of the work was to evaluate the diversity of existing arthropods in an aronia plantation within the experimental plots of RSFG Iași. The experience was organized in four variants: V1- in which approved treatments for ecological agriculture were applied; V2- ecological treatments and irrigation, V3- in which approved conventional treatments, V4-conventional treatments and irrigation, each variant having three repetitions. Arthropod densities were sampled using Barber-type soil traps, in which the fixing solution was sodium chloride (NaCl) with a concentration of 25%. The harvestings were made periodically, from the beginning of May to the end of September 2022. The structure of the collected material varied according to the experimental variant. The arthropod fauna was made up of species that systematically fall into the following orders: Coleoptera, Hymenoptera, Heteroptera, etc.

Key words*: arthropods, black chokeberry, treatments, useful entomofauna.*

INTRODUCTION

Black chokeberry (*Aronia melanocarpa* L.) is a shrub native from North America being one of the most cultivated species in recent years in Romania (Chiorean et al., 2023). This berry shrub is cultivated especially for the astringent fruits, which is very high in several healthful compounds, but are introduced in landscape design compositions or isolated plant, also fulfilling an ornamental role (Çelik et al., 2022, Ünal et al., 2023). In the studies and observations carried out over time, aronia is a plant with high ecological plasticity, having the ability to capitalize very well on a diversity of pedo-climatic conditions. This fact was highlighted by the reporting of this species in the spontaneous flora and considered an invasive species in some habitats (Vinogradova et al., 2018; Dinu et al., 2022).

Being a perennial crop, aronia makes use of the same land for a longer period of time, and the shrubby habitus can accommodate both useful and harmful fauna to the ecosystem. Known to be a shrub without too many pests, it is part of the Rosaceae family and can be attacked by specific diseases and pests: aphids, mites, bedbugs or cycads. The choice of host plants by the phytophagous insects depends on number of factors which have a significant influence or not on the physiology and behaviour of plant-eating insects but also on the chemism of plants defense (Piersanti et al., 2023).

Recently, one of first insect problems seen in the flowering time of aronia was with *Lytta* sp. and *Epicometis hirta* Poda (Tretiacova & Todiraș 2017) which consumes the inflorescences. Some studies refer to the *Acrobasis advenella* Zinck., whose larvae feed on inflorescences (Górska-Drabik et al., 2013). Thus, the damage caused by some pests may be increasing in these plantations and the application of pesticides that have increased toxicity have negative effects on the environment and may produce large imbalances on the ecosystems.

Therefore, modern control methods that involve ecological methods, but also natural methods that are based on the ability of the

biosphere to self- adjustment are being promoted a lot (Wackernagel & Galli, 2007).
The aim of this work was to evaluate and compare the diversity of existing arthropods in an aronia plantation under the four experimental variants. This will determine the subsequent choice of the most effective cultural methods in aronia plantations.

MATERIALS AND METHODS

This study was carried out in a chokeberry crop from the experimental plot of Research Station for Fruit Growing Iași. The site is located in the forest steppe of Moldova (47°20´N; 27°60´E, 165 m altitude) on the geomorphological unit characterized by a meso-relief where the predominant type of soil is cambic chernozem. The climate of this area is considered Dfb type according to the Köppen-Geiger classification (Belda et al., 2014) with an average annual temperature of 10.2°C and a significant rainfall of 562.6 mm, usually distributed throughout the year.
The experience was organized in four variants, with three replied, as follows:
V1 - in which approved treatments for ecological agriculture were applied;
V2 - ecological treatments and irrigation;
V3 - in which approved conventional treatments;
V4 - conventional treatments and irrigation.
In the V2 and V4 variants was used drip irrigation at different water regimes depending on the rainfall and the needs of the plants in different phenological stages. Thus, the soil water content in the depth of 0-50 cm was increased up to the capacity of the field by applying a watering rate of 6 litres/hour.
During the study period, the diversity of existing arthropods was evaluated within the experimental variants. Their collection was done with the help of Barber-type method and the samples were taken every 14 days between May and September. The trap consisted of 0.8 litre glass cups with an opening of 8.0 cm diameter. They were protected from the rain and other impurities with 10 × 10 cm metal roofs.
The soil traps were placed three on each variant at a distance of 10 meters. The containers were placed at ground level in which a fixing solution of sodium chloride (NaCl) with a concentration of 20% was added.
By placing the 12 traps, all categories of arthropods can be collected from the biotope, in order to later establish some ecological indicators such as abundance (A), constancy (C), dominance (D), the index of ecological significance (W).
Abundance (A) is the representation of a species in a certain ecosystem that is usually measured in the number of individuals captured per sample (Bonar et al., 2011). Based on this indicator, the other indicators are calculated (Vălean et al., 2018).
Constancy (C) is a structural indicator expressed by the continuity of the appearance of a species in the analyzed biotope. The higher value of this indicator, the better adapted the respective species is to the conditions encountered in the respective biotope (Battes, 2018).
Constancy was expressed according to the following formula:

$$C_A = \frac{n_p A}{N_p} \times 100, \text{ where:}$$

C_A - the constancy of species A; n_pA - the number of samples in which the species A is present;
N_p - total number of investigated samples.
Dominance (D) is considered to be an indicator of productivity, expressing the relationship of the population of a species to the sum of other associated species. Thus, this indicator shows the percentage of participation of the species in the catches. Dominance (D) was calculated using the relation:

$$D_A = \frac{n_A}{N} \times 100, \text{ where:}$$

D_A - species dominance; n_A- total number of individuals belonging to species; A, present in the samples researched; N - total number of individuals belonging to all the species present in the samples researched.
The ecological significance index (W) represents the relationship between the structural indicator (C) and the productivity indicator (D), reflected by following formula used:

$$W_A = \frac{C_A \times D_A \times 100}{10000}, \text{ in which:}$$

W_A - ecological significance index of the species A; C_A - species constancy; D_A - species dominance.

On each harvest date, the biological material captured from each trap was separated from the fixative liquid and placed in boxes with a 40% alcohol solution to preserve the elasticity of the insects and anesthetize the live ones. Further, each trap was reinserted in the soil and the fixative fluid be replaced. The collected entomological material was brought to the laboratory, and the insects were determined and Inventoried with the help of Reitter (1908) and Panin (1952) determinants.
Also, during this study the air temperature and rainfall was recorded by AgroExpert system, located in the experimental field.

RESULTS AND DISCUSSIONS

The observations and determinations were carried out in 2022 in the aronia plantation where the diversity and distribution of arthropods existing in this biotope was studied. Their dynamics, diversity and distribution are directly and indirectly affected by the variations of abiotic factors (Majed et al., 2020). Thus, during the study period, an average annual temperature of 11.4°C and an amount of precipitation of 379.0 mm were recorded, with a thermal deviation of +1.2°C and a precipitation deficit of -183.6 mm compared to the multiannual averages (Figure. 1).

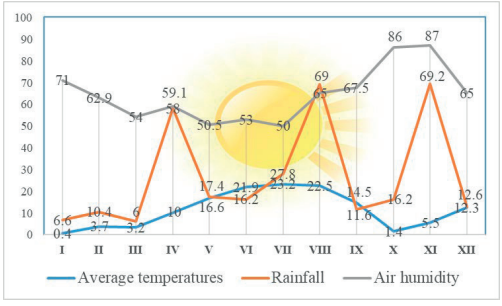

Figure 1. Dynamics of climate factors in 2022 at RSFG Iași

The collections of the arthropods using Barber traps were done on the following dates: 20.05.2022; 06.06.2022; 20.06.2022; 01.07.2022; 15.07.2022; 29.07.2022; 12.08.2022; 26.08.2022; 15.09.2022. During this period, a number of 3715 specimens of arthropods belonging to the *Insecta* and Arachnida classes were collected, distributed in the following orders: *Araneae*, *Coleoptera*, *Collembola*, *Dermaptera*, *Diptera*, *Hemiptera* with suborders *Heteroptera* and *Homoptera*, *Hymenoptera*, *Isopoda*, *Orthoptera*.
The *Coleoptera* order had the largest share with a total number of 1193 captured specimens belonging to 57 species. The order Hemiptera had 628 specimens of which 360 were of the suborder *Heteroptera* and 268 of the suborder *Homoptera*. The following representatives were the order Isopoda with 435 specimens; *Araneae* with 421 specimens, *Hymenoptera* with 365 specimens. The orders *Diptera* and *Orthoptera* recorded 223, respectively 175 specimens during the study. The presence in the form of a colony of species from the *Collembola* order made it impossible to calculate the number of specimens from the nine harvests. In the centralized table no. 1, the dynamics of catches during the study period can be observed, directly influenced by various factors: temperature, humidity, inter-specific relationships. Thus, the highest abundance of species was recorded at the third harvest, on 20.06.2022, with a number of 541 specimens. In this sample, the Coleoptera order had the largest share with a number of 248 specimens. From this order, the species *Harpalus distingunedus* Duft. and *Pterostichus cupreus* L. were the most abundant with 97 and 22 specimens, respectively. The next two samples recorded a number of specimens of 539 and 477, respectively, the taxa belonging to the orders *Coleoptera*, followed by *Araneae* and *Heteroptera*, to 208 and 34 species, respectively and taxa, respectively. The seventh harvesting date (12.08.2022) registered the lowest sample of arthropods in a number of 255 specimens, of which the greatest abundance was an isopod with 35 specimens of *Armadillidium vulgare* L., followed by the orders *Homoptera*, *Araneae*. Correlating the climatic factors (Figure. 1) with the dynamics of arthropods collected in the nine times (Table 1), it can be observed that there is a significant influence on the density and structure of the arthropod communities in the aronia crop. The density of arthropods varied over the growing season. Most arthropod groups were abundantly found in the spring-summer growing season. This is also confirmed by other research on arthropod distribution in

different microenvironments along growing season on shrubs and various plants (Rango, 2005; Liu et al., 2013; Majeed et al., 2020). In the present study a significant positive relationship was found between arthropod diversity and temperature, with mouth average between 16.2°C and 23.2°C in June and July. Humidity showed a significant negative relationship with the diversity of entomofauna, on August was 69.0 mm of precipitation, with an excess of 18.2 mm compared to the multiannual average.

Table 1. The arthropods collected from the aronia plantation with the soil traps Barber method at RSFG Iași in 2022

No.	Order	Specie	No of harvesting									Total samples
			I	II	III	IV	V	VI	VII	VIII	IX	
1.	Araneae		58	45	55	57	56	27	35	52	36	421
2.	Coleoptera	*Amara aenea* De Geer			13	8	10	6				37
		Amara crenata Dejean	15	1								16
		Anisodactylus binotatus F.			3		6					9
		Anthicus floralis L.	2	2	3	6	7	2				22
		Anthicus humeralis Gebler				2	1		3			6
		Apion tenue K.	3									3
		Apion violaceum Gyll.			2	2						4
		Brachinus crepitans L.	1	2	5					10		18
		Brachinus explodens Duft.				2		3		1		6
		Brachinus psophia Serv.								1	1	2
		Cantharis violacea Thun.	2									2
		Carabus coriaceus L.			4				1	3	1	9
		Cartodere elongata Curt.	1									1
		Coccinella 12 punctata L.							1			1
		Coccinella septempunctata L.	2	2								4
		Corticaria longicornis Herbst	1									1
		Cymindis vaporariorum L.	2	1								3
		Dermestes laniarius Illi.	5	12	36	15	9		3	6		86
		Formicomus pedestris Rossi				3		1				4
		Harpalus distinguendus Duft.	65	78	97	62	10	2		37	35	386
		Harpalus aeneus F.				2	2			26	14	44
		Harpalus azuereus F				2				1	1	4
		Harpalus calceatus Duft.	1		12	15	3	4	11	25	17	88
		Harpalus griseus P.	10	18				1	1	23	14	67
		Harpalus picipennis Duft.	1									1
		Harpalus pubescens Müll	1		10	19	56	7	3	44	14	154
		Harpalus rufipes Deg.					18			9		27
		Harpalus tardus P.	2						2	4		8
		Hister funestus E.		1	4							5
		Hister neglectus G.	4		10							14
		Hister purpurascens Herbst.	2	5								7
		Leistus rufescens F.				1						1
		Longitarsus brunneus Duft.					1	1				2
		Longitarsus luridus S.								1		1
		Malachius bipustulatus L.		1	2							3
		Medon melanocephalus L.								1		1
		Ontophagus ovatus L.				2						2
		Opatrum sabulosum L.	20		19		23					62
		Otiorhynchus fuscipes Oliv.	3									3
		Otiorhynchus sensitivus S.			1							1
		Oxypora vittata L.						1				1
		Oxytelus rugosus F.								2		2
		Oxytelus sculpturalis Grav.								1		1
		Phyllotreta nigripes F.								1		1
		Phyllotreta vittula R.					2					2
		Podagrica malvae Illi.	1									1
		Pterostichus cupreus L.			22	9				4	5	40
		Pterostichus niger Sch.			1	3	4		2			10
		Pterostichus signatus L.				1						1
		Pteryngium crenatum Gyll.	1	1						1		3
		Scymnus frontalis F.						1				1
		Staphylinus erythropterus L				2						2
		Staphylinus pubescens De Geer.				1						1
		Tachyporus hypnorum F.	2		3							5
		Tachyporus nitidulus F	1		1							2
		Thiasophila inquilina Märkel	2									2
		Valgus hemipterus L.	1			2						3
3	Collembola		51	38	colony	43	59	colony	colony	29	34	254
4	Dermaptera				8	4			2	7		21
5	Diptera		23	25	47	32	21	16	20	15	24	223

No.	Order	Specie	No of harvesting									Total samples
			I	II	III	IV	V	VI	VII	VIII	IX	
6	Hemiptera	Heteroptera	69	36	67	76	48	5	12	40	7	360
7		Homoptera	26	18	20	31	57	45	39	20	12	268
8	Hymenoptera		47	38	31	62	41	46	35	40	25	365
9	Isopoda		25	34	47	39	52	68	77	56	37	435
10	Orthoptera		16	22	18	35	17	25	11	17	14	175
Total			440	380	541	539	477	261	255	470	291	3715

From another perspective, the ecological parameters of each experimental variant were analyzed in the study. Thus, variants 1 and 2 were treated with products allowed in ecological culture, and variants 3 and 4 with conventional products. The treatments for V1 and V2 including products based on copper, parafinic oil, natural plant extract such as Ovipron Top (0.2 %), Wetcit (0.25%), Laser 240 SC (0.06 %), Deffort (0.3 %), Funguran OH 300 SC (0.06%) to which biostimulants against biotic and abiotic stress were added (Mimox 0.2%, Altosan 0.25 %).

The conventional products for V3 and V4 treatments including Toil (0.5%), Mospilan (0.02%), Vertimec 1.8% EC (0.1%), Score 250 EC (0.03%), Merpan 80 WDG (0.15 %).

Figure 2. Aspects regarding the experimental plot and sampling

Within V1, the most abundant arthropods belong the *Coleoptera* order (371 specimens), following *Hymenoptera* group (217 specimens represinted by Formicidae and *Vespidae*, parasites entomophaguos) and *Isopoda* order (217 species). The mentioned orders are characterized in the categories of constant and euconstant species depending on the indicator (C) which expresses the continuity and appearance of the species in the analyzed biotope (Table 2). The accidental species (C1) encountered in this variant was represented by *Forficula auricularia* L. (*Dermaptera* ord.), which is considered also recedent species (D2), by dominance. According to the classification of ecological index W, the values were between 0.22% (*Dermaptera* ord.) and 36.37 (*Coleoptera* ord.).

Table 2. Ecological parameters analysis of the species collected in the aronia culture at V1

Order	(A)	(C)		(D)		(W)	
		%	Cl.	%	Cl.	%	Cl.
Araneae	102	85.18	C4	10.00	D4	8.52	W4
Coleoptera	371	100	C4	36.37	D5	36.37	W5
Dermaptera	12	18.51	C1	1.18	D2	0.22	W1
Diptera	14	25.92	C2	1.37	D2	0.36	W1
Heteroptera	76	55.55	C3	7.45	D4	4.14	W3
Homoptera	43	37.03	C2	4.22	D3	1.56	W3
Hymonoptera	217	70.37	C3	21.27	D5	14.97	W5
Isopoda	148	74.07	C3	14.51	D5	10.75	W5
Orthoptera	37	44.44	C2	3.63	D3	1.61	W3

Variant 2 (V2), in addition to the administration of organic treatments, it also benefited from irrigation, which changed the abundance and dominance of arthropod populations (Table 3). The abundance of *Coleoptera* increased to 402 specimens belong to the genre *Amara*, *Apion, Dermestes*, *Harpalus*, *Opatrum*, *Otiorhynchus*, following by *Isopoda* (217 specimens) and *Hymenomoptera* (196 specimens). In this sample the euconstant species (C4) belonged to orders *Araneae*, *Coleoptera* and *Isopoda* and the constant species (C3) are orders *Orthoptera* and *Hymenoptera*. The other orders are accessory species (C2) within the sample. Regarding the dominance, *Diptera* ord. was

included in the subreceding species (D1), *Dermaptera* ord. recordered in the receding species (D2). No group of arthropods is included in this variant as being subdominant, the rest that were not mentioned are either dominant (D4) or eudominant (D5). Ecological significance index recorded values between 0.43% (*Diptera*) and 34.44 (*Coleoptera*).

Table 3. Ecological parameters analysis of the species collected in the aronia culture at V2

Order	(A)	(C)		(D)		(W)	
		%	Cl.	%	Cl.	%	Cl.
Araneae	95	85.18	C4	8.11	D4	6.91	W4
Coleoptera	402	100	C4	34.33	D5	34.33	W5
Dermaptera	15	33.33	C2	1.28	D2	0.43	W2
Diptera	11	29.62	C2	0.94	D1	0.28	W2
Heteroptera	89	48.14	C2	7.60	D4	3.66	W3
Homoptera	78	40.74	C2	6.66	D4	2.71	W3
Hymonoptera	196	66.66	C3	16.74	D5	11.16	W5
Isopoda	217	92.59	C4	18.53	D5	17.16	W5
Orthoptera	68	74.07	C3	5.81	D4	4.30	W3

In the conventionally treated variants V3 and V4, the number of arthropods collected decreased significantly, under the action of the applied products. Thus, within V3, 759 specimens were analyzed. Compared to the previous versions, the number of coleopterans decreased, the sample having only 296 specimens. The index of constancy was between 14.81% and 92.59%. The most adapted species to the conditions of this biotope being *Coleoptera* (92.59 %), *Isopoda* (85.18 %) and *Hymenoptera* (81.48%) species. The dominance of arthropods varies between 0.92% (*Dermaptera*) and 39.00% (*Coleoptera*), while ecological significance index (W) has values between 0.14 % and 36.11 for the same orders (Table 4.).

Table 4. Ecological parameters analysis of the species collected in the aronia culture at V3

Order	(A)	(C)		(D)		(W)	
		%	Cl.	%	Cl.	%	Cl.
Araneae	47	48.44	C2	6.19	D4	3.00	W3
Coleoptera	296	92.59	C4	39.00	D5	36.11	W5
Dermaptera	7	14.81	C1	0.92	D1	0.14	W2
Diptera	19	44.44	C2	2.50	D3	1.11	W3
Heteroptera	75	70.37	C3	9.88	D4	6.95	W3
Homoptera	52	62.96	C3	8.17	D4	5.14	W4
Hymonoptera	95	81.48	C4	12.52	D5	10.20	W5
Isopoda	104	85.18	C4	13.70	D5	11.67	W5
Orthoptera	41	70.37	C3	7.11	D4	5.27	W4

Variant 4 (V4) was treated conventionally and irrigated. Thus, the results in table 5 show that compared to the previous version, the abundance of arthropods changed, with 788 specimens captured. It can be seen that humidity had a positive influence on the orders *Coleoptera*, *Diptera*, *Isopoda*, *Homoptera* and *Orthoptera.* The orders *Araneae, Dermaptera*, *Heteroptera* and *Hymenoptera* registered decreases regarding the number of specimens within this variant. This sample included all the classes from the point of view of the constancy. Regarding dominance values are between 0.76 % (*Dermaptera*) and 39.97 (*Coleoptera*) with the ecological significance index between 0.08-39.97%.

Table 5. Ecological parameters analysis of the species collected in the aronia culture at V4

Order	(A)	(C)		(D)		(W)	
		%	Cl.	%	Cl.	%	Cl.
Araneae	31	59.25	C3	3.93	D4	2.33	W3
Coleoptera	315	100	C4	39.97	D5	39.97	W5
Dermaptera	6	11.11	C1	0.76	D1	0.08	W1
Diptera	34	25.92	C2	4.31	D3	1.12	W3
Heteroptera	48	40.74	C2	6.09	D4	2.48	W3
Homoptera	61	48.14	C2	7.74	D4	3.73	W3
Hymonoptera	79	51.85	C3	10.03	D5	5.20	W4
Isopoda	173	92.59	C4	21.95	D5	20.33	W5
Orthoptera	54	70.37	C3	5.20	D4	3.66	W3

In Figure 3, the abundance of arthropods collected in the three experimental variants are graphically represented. It can be seen that the two experimental factors (applied treatments and irrigation) influenced the presence of epigean entomofauna. It is also observed that their number fluctuated between variants, but there were also variations within the collected orders.

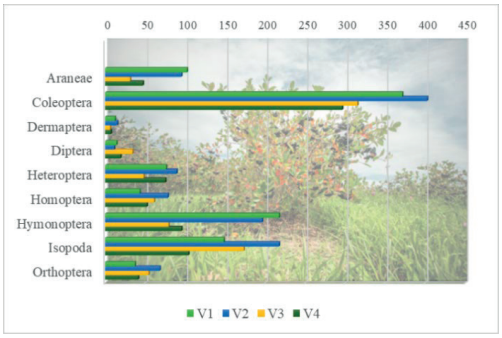

Figure 3. The abundance of arthropods collected in the experimental variants

CONCLUSIONS

In the study carried out, the structure and diversity of arthropods existing in an aronia plantation was investigated, within four experimental variants. In the period from May to September 2022 nine harvest of arthropods were recorded. thus, it was observed that the density of arthropods varied greatly over the growing season. Most arthropod groups were abundant found in the spring-summer growing season.

When performing the determination, inventory and structuring the specimens, it was observed that not only the abundance, but also the diversity of the species has a positive correlation with the structure of the vegetation. From another point of view, the seasonal change of the species found in chokeberry culture was influenced by abiotic factors, but also by inter-specific relationships.

The results obtained, but also the deepening of these studies, can be useful in the development of biological control strategies and the protection of aronia crops and others

Thus, it was concluded that the highest abundance was recorded within variants V1 and V2, respectively 1020 and 1171 belonging to the orders *Araneae, Coleoptera*, *Dermaptera*, *Diptera*, *Collembola, Heteroptera*, *Homoptera*, *Hymenoptera*, *Isopoda* and *Orthoptera.*

The application of conventional products influenced the density of arthropods in samples V3 and V4, their number being decreasing 736, respectively 788 comparing to the previous ones.

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