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RESEARCH ON THE SPECIES OF CARABIDS EXISTING IN SUNFLOWER CULTURE, DEPENDING ON THE APPLIED TECHNOLOGY

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Abstract
The observations were made in a sunflower crop in the north-western extremity of Arad County, in the immediate vicinity of the town Adea, using two variants:
Variant 1 (V1), where there were no treatments for the chemical control of the pathogenic agents of the pests.
Variant 2 (V2), where chemical treatments were made to the seeds and during the vegetation period against pathogens and pests. In the ecological variant, a larger number of specimens and species were collected in each of the 10 collections compared to the conventional variant, where chemical treatments were carried out to combat pathogens and pests. The most frequently collected carabid species were Pterostichus cylindricus, Pseudophonus pubescens, and Pseudophonus griseus, in both variants. In total, 501 carabid specimens belonging to 16 species were collected in the ecological variant, and 243 specimens belonging to a total of 10 species were collected in the conventional variant.

Keywords: carabids, harvest, sunflower, variant

1. INTRODUCTION

Sunflower is considered one of the most profitable field crops. Having a wide spectrum of use, it not only represents a solution in the supply of vegetable oil but also makes a great contribution to the increase in albumin production and organic and mineral products (Bîlteanu, 2003).
Sunflower seeds contain 33–56 percent oil with high nutritional value, determined by the presence of unsaturated fatty acids, represented mostly by linoleic (44–75%, high content) and oleic (14–43%) acids (medium level), but also by the presence of less than 15 percent saturated fatty acids (especially palmitic and stearic). This fact gives it stability and long-term preservation capacity (Păcureanu-Joiţa et al., 2007).
Recently, due to the development of the biodiesel industry as well as the increase in the non-food use of vegetable oils, consumer interest in all oilseeds in the world is growing rapidly. Today, one of the main places in the world ranking of oil crops is occupied by the sunflower. The global sunflower market in recent years has been characterized by a considerable increase in the global harvest and the areas sown with this crop (Iatisin, 2017).
Carabids are a diverse group of insects in the family Carabidae, which are often known as ground beetles (Baban, 2005). They are effective natural predators and play an important role in pest control in various agricultural ecosystems, including sunflower crops.

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Here are some carabid species that are important in sunflower culture (Bennewicz and Barczak, 2020):
Carabus spp.: These are among the largest species of carabids and are known for their consumption of pests such as worms, grubs, and other insects that might affect sunflower crops.
Harpalus spp.: These carabids are mostly active at night and feed on a variety of agricultural crop pests, including caterpillars and beetle larvae.
Chlaenius spp.: These carabids are agile predators and feed on pests that attack the roots and stems of sunflower plants.
Calosoma spp.: These carabids are known for their hunting skills and are effective in controlling sunflower plant pests such as leaf beetles and other small insects.
Cicindela spp.: These carabids, also known as ground fireflies, are fast predators that feed on small insects such as beetles and ants that could damage sunflower plants.
Nebria spp.: These carabids are fast predators and feed on pests that attack sunflower plants, such as slugs and beetles.
These carabid species contribute to the maintenance of ecological balance in sunflower crops, helping to reduce pest populations and maintain plant health without the need for extensive chemical intervention.

2. MATERIALS AND METHODS

The scientific research was carried out during the vegetation period of the years 2022–2023 on three agricultural crops located in the north-western extremity of Arad County, in the immediate vicinity of the town of Adea.
In order to achieve the research objectives, two work variants located in the same location were studied for each culture:
V1: untreated crops;
V2: crops to which treatments have been applied against pathogens and pests.

Treatment of the crops studied in 2022:
a. Treatments used on seeds:
- the following chemicals were used to treat wheat seeds: Permis 700 WS and Bariton Super 97.5 FS;
- The following chemicals were used to treat sunflower seeds: Permis 700 WS and Apron XL
- The following chemicals were used to treat corn seeds: Permis 700 WS and Lebosol.

b. Treatments used on vegetation:
- The following substances were used to treat the corn crop: Dicopur D and Elumis.
- The following substances were used to treat the sunflower crop: Mirage 45 EC and Pyrus 400;
- The following substances were used to treat the wheat crop: Attribut 70 and Hussar Activ OD.

For the study year 2022, the crops preceding the sunflower crop were corn.
The samples were collected using Barber traps (Figure 1); this method is effective for capturing species with high abundance and mobility (Jorge Cepeda-Pizarro, 2013). Collections were carried out on wheat, corn, and sunflower crops. The entomological material was collected by means of 24 Barber-type soil traps in each crop, or more precisely, 12 Barber-type soil traps for each variant, during the entire vegetation period.

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Figure 1. Soil trap type Barber

The traps were made of plastic containers filled with a solution of acetic acid, a solution also used in other studies (Seaby, R.M.H. et al., 2007). The traps were buried at ground level. The location of the Barber traps was made in the shape of a circle at a distance of 10 m between them.
Plastic jars with a volume of 1000 ml, 13.5 cm wide, and 12.0 cm high were used to collect the entomological material. As a fixative-preservative liquid, 50% diluted acetic acid was used, to which a few drops of detergent were added to reduce the surface tension. Specimens captured there were collected and tagged. Labeled samples were protected from sunlight and transported to the laboratory for analysis and determination (Ellis, M.V. 2013).
Barber traps were installed at the emergence of seedlings (early May), harvested, and replaced. The material was collected biweekly. The collected samples of biological material were taken to the laboratory, where they were inventoried and cleaned, and then the collected carabids were determined. The determination of the material was carried out with the help of the entomological key book, a stereomicroscope, binocular magnifier, and the inventory made available by the USV-Iași institution (Figure 2).

Figure 2. The inventory of the entomological material collected

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3. RESULTS AND DISCUSSIONS

In 2022, using the Barber trap method, a total of 10 periodic collections of biological material were carried out in the sunflower culture on the following dates (Table 1): 15.05, 29.05, 12.06, 26.06, 10.07, 24.07, 07.08, 21.08, 04.09, and 18.09.

Table 1. Harvest data for coleopteran entomofauna using Barber traps in the 2022 research year

No.	Variant	Harvest dates
1.	V1 – the control, untreated version	15.05.2022
		29.05.2022
		12.06.2022
		26.06.2022
		10.07.2022
		24.07.2022
		07.08.2022
		21.08.2022
		04.09.2022
		18.09.2022
2.	V2 – the variant with seed treatment and vegetation treatment	15.05.2022
		29.05.2022
		12.06.2022
		26.06.2022
		10.07.2022
		24.07.2022
		07.08.2022
		21.08.2022
		04.09.2022
		18.09.2022

The species with the largest number of specimens collected in the two variants were *Pseudophonus griseus, Pterostichus cylindricus*, and *Pseudophonus pubescens*.

During the third harvest carried out on June 12, 2023 (Tabel 2), 102 carabid specimens belonging to a number of 6 species were collected in the ecological variant (V1), and 26 specimens were collected in the conventional variant (V2), belonging to a number of 4 species (Tabel 3). The species with the highest number of specimens in both variants were *Preudophonus pubescens* and *Pterostichus cylindricus*.

During the IV harvest carried out on June 22, 2022, 93 carabid specimens belonging to a number of 5 species were collected in the ecological variant (V1), while in the conventional variant, 33 carabid specimens were collected belonging to a number of 6 species. The species with the highest number of specimens in both variants were *Pterostichus cylindricus, Preudophonus pubescens* and *Pseudophonus griseus*.

During the V harvest carried out on July 10, 2022, 71 carabid specimens belonging to a number of seven species were collected in the ecological version (V1), while 19 carabid specimens were collected in the conventional version (V2), belonging to two species. The species with the highest number of specimens in both variants were *Preudophonus pubescens* and *Pseudophonus griseus*.

During the VI harvest carried out on July 24, 2022, 33 carabid specimens belonging to a number of 5 species were collected in the ecological version (V1), while 23 carabid specimens were collected in the conventional version (V2) belonging to a number of 4 species.

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Table 2. The situation of the collections for the two variants, from the sunflower culture in 2022 at variant 1

No	Name of species	Harvest 1- V1- 15.05.2022												Total
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	
1.	*Pterostichus cylindricus*	2	1	3	-	4	-	1	1	2	3	-	-	17
2.	*Harpalus distinguendus*	1	-	-	1	-	-	2	-	-	-	-	-	4
3.	*Calatus fuscipes*	2	1	-	-	-	-	-	-	-	-	-	-	3
4.	*Pseudophonus griseus*	2	3	-	3	-	-	2	-	-	-	3	-	13
5.	*Pseudophonus pubescens*	-	5	2	5	-	-	4	5	-	-	3	-	24
6.	*Amara similata*	-	1	-	-	-	-	-	-	-	-	-	-	1
7.	*Pterostichus niger*	-	-	1	-	1	-	-	-	-	-	-	-	2
8.	*Harpalus tardus*	-	-	-	-	-	-	1	-	-	-	1	-	2
9.	*Platynus assimilis*	-	-	-	-	-	-	-	-	-	-	1	-	1
10.	*Harpalus aeneus*	-	-	-	-	-	-	-	-	-	-	1	-	1
11.	*Leistus ferrugineus*	-	-	-	-	-	-	-	-	-	-	1	-	1
Total 11 species		7	11	6	9	5	0	10	6	2	3	10	0	69
Harvest 2 - V1- 29.05.2022														
1.	*Pseudophonus pubescens*	8	-	4	5	2	-	-	3	-	-	4	-	26
2.	*Pseudophonus griseus*	2	6	2	1	12	-	-	6	-	-	3	-	32
3.	*Calatus fuscipes*	1	-	-	-	-	-	-	-	-	-	-	-	1
4.	*Pterostichus cylindricus*	-	5	1	1	-	1	2	1	-	2	1	2	16
5.	*Amara familiaris*	-	3	-	-	-	-	-	-	-	-	-	-	3
6.	*Ophonus puncticollis*	-	1	-	-	-	-	-	-	-	-	-	-	1
7.	*Bembidion ruficorne*	-	1	-	-	-	-	-	-	-	-	-	-	1
8.	*Harpalus distinguendus*	-	-	2	-	-	-	-	-	-	-	-	-	2
9.	*Carabus coriaceus*	-	-	-	-	-	-	1	-	-	-	-	-	1
Total 9 species		11	16	9	7	14	1	3	10	0	2	8	2	83
Harvest 3- V1- 12.06.2022														
1.	*Pterostichus cylindricus*	1	1	1	-	-	-	-	-	-	-	1	-	4
2.	*Pseudophonus pubescens*	3	18	4	8	9	4	7	13	5	2	15	3	91
3.	*Carabus coriaceus*	-	1	-	-	-	-	-	-	-	-	1	-	2
4.	*Harpalus distinguendus*	-	-	1	-	-	-	-	-	-	-	-	-	1
5.	*Calatus fuscipes*	-	-	-	-	1	-	-	-	-	-	-	-	1
6.	*Pseudophonus griseus*	-	-	-	-	-	-	2	1	-	-	-	-	3
Total 6 species		4	20	6	8	10	4	9	14	5	2	17	3	102
Harvest 4 - V1- 22.06.2022														
1.	*Pterostichus cylindricus*	2	7	1	-	1	2	12	8	1	-	1	-	35
2.	*Pseudophonus pubescens*	2	-	1	11	7	1	2	-	3	-	-	-	27
3.	*Pseudophonus griseus*	-	2	-	-	-	-	-	2	1	12	4	6	27
4.	*Pterostichus niger*	-	-	-	-	-	-	1	-	-	-	2	-	3
5.	*Pterostichus lepidus*	-	-	-	-	-	-	1	-	-	-	-	-	1
Total 5 species		4	9	2	11	8	3	16	10	5	12	7	6	92
Harvest 5 - V1- 10.07.2022														
1.	*Pseudophonus pubescens*	1	9	5	7	7	1	2	6	-	4	4	2	46
2.	*Pseudophonus griseus*	1	-	-	2	1	-	1	3	1	-	-	-	9
3.	*Pterostichus cylindricus*	1	-	1	-	-	1	2	-	1	1	1	1	9
4.	*Harpalus distinguendus*	-	1	-	-	-	-	-	-	-	1	-	-	2
5.	*Pterostichus lepidus*	-	1	1	1	-	-	-	-	-	-	-	-	3
6.	*Ophonus puncticollis*	-	-	-	-	1	-	-	-	-	-	-	-	1
7.	*Harpalus tardus*	-	-	-	-	-	-	-	1	-	-	-	-	1
Total 7 species		3	11	7	10	9	2	5	10	2	6	3	3	71
Harvest 6 - V1- 24.07.2022														
1.	*Pterostichus cylindricus*	2	1	-	2	3	1	1	2	-	1	1	1	15
2.	*Pseudophonus pubescens*	2	1	-	1	1	1	2	2	-	1	1	-	12
3.	*Pterostichus niger*	-	1	-	-	-	-	-	-	-	-	-	-	1
4.	*Pseudophonus griseus*	-	-	-	-	-	-	3	-	-	-	-	-	3
5.	*Harpalus distinguendus*	-	-	-	-	-	-	1	1	-	-	-	-	2

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Total 5 species		4	3	0	3	4	2	7	5	-	2	2	1	33
Harvest 7 - V1- 07.08.2022														
1.	*Pterostichus cylindricus*	1	-	-	1	-	-	2	2	-	1	1	-	8
2.	*Pseudophonus pubescens*	1	-	-	-	-	-	1	1	-	-	-	-	3
3.	*Pterostichus niger*	-	-	-	-	1	-	-	-	-	-	-	1	2
4.	*Pseudophonus griseus*	-	-	-	-	-	-	1	-	-	-	1	-	2
Total 4 species		2	0	0	1	1	0	4	3	0	1	2	1	15
Harvest 8 - V1- 04.09.2022														
1.	*Pterostichus cylindricus*	1	1	-	-	1	-	-	-	-	1	1	2	7
2.	*Pterostichus niger*	-	-	-	-	-	-	-	1	-	-	-	-	1
3.	*Pseudophonus pubescens*	1	1	-	-	-	-	-	-	-	-	-	1	3
4.	*Pseudophonus griseus*	-	1	-	-	2	-	-	1	-	-	1	-	5
Total 4 species		2	3	0	0	3	0	0	2	0	1	2	3	16
Harvest 9 - V1- 18.09.2022														
1.	*Pseudophonus pubescens*	1	-	-	-	-	-	-	1	-	-	-	1	3
2.	*Pterostichus cylindricus*	1	-	-	1	-	-	-	-	-	-	1	-	3
3.	*Pseudophonus griseus*	-	-	-	-	-	-	-	1	-	-	1	-	2
4.	*Pterostichus niger*	-	-	-	-	-	-	-	1	-	-	-	-	1
Total 4 species		2	0	0	1	0	0	0	3	0	0	2	1	9

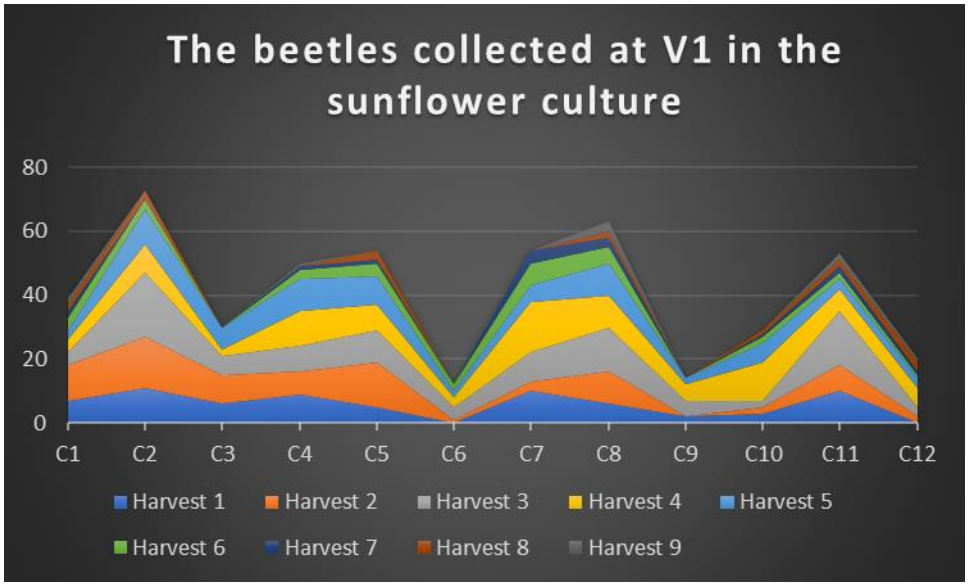

Figure 3. The beetles cillected at V1 in the sunflower culture

We can observe general trends and variations depending on the collection periods.

• *Pterostichus cylindricus*: The amount collected for this species appears to be variable from one collection set to another, with notable fluctuations. The largest amounts collected appear to be between harvests 1, 2, and 4, while collections 3, 5, 6, and 7 appear to have lower amounts (Figure 3).

• *Pseudophonus pubescens*: We observe a significant increase in collection 3, after which the amount collected fluctuates but remains relatively high compared to other species.

• *Pseudophonus griseus*: The quantities collected for this species are quite variable over time, with some notable fluctuations, such as the significant increase in harvesting 2.

• *Harpalus distinguendus*: The quantities collected for this species are relatively small and vary slightly from one harvest to another.

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• *Calatus fuscipes*: The quantities collected are relatively small, and there is little variation between harvests.
• Other species: For species with small amounts collected, we cannot draw clear conclusions due to low variability and low amounts.

Table 3. The situation of the collections for the two variants, from the sunflower culture in 2022 at variant 2

No	Name of species	V2- 15.05.2022												Total
		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	
	Pterostichus cylindricus	2	2	-	2	2	2	2	2	-	4	3	-	21
2.	*Harpalus distinguendus*	-	-	-	-	-	-	-	1	-	-	-	-	1
3.	*Pseudophonus griseus*	-	-	-	-	-	1	3	1	-	-	-	-	5
4.	*Pseudophonus pubescens*	4	-	-	1	-	2	3	2	-	-	2	-	14
5.	*Pterostichus niger*	-	-	-	1	-	-	-	-	-	-	-	-	1
Total 5 species		6	2	0	4	2	5	8	6	-	4	5	-	42
V2 - 29.05.2022														
	Pseudophonus pubescens	7	5	-	-	-	-	5	3	-	3	-	-	23
2.	*Pseudophonus griseus*	3	-	-	-	-	-	2	1	-	-	-	-	6
3.	*Pterostichus cylindricus*	1	2	4	3	2	1	5	2	2	2	4	1	29
4.	*Harpalus distinguendus*	-	-	-	-	-	-	1	-	-	-	-	-	1
5.	*Pterostichus niger*	-	-	-	1	-	-	-	1	-	-	-	-	2
6.	*Nebria brevicollis*	-	-	-	-	-	-	1	-	-	-	-	-	1
Total 6 species		11	7	4	4	2	1	14	7	2	5	4	1	62
V2- 12.06.2022														
	Pterostichus cylindricus	1	1	2	1	1	-	2	2	1	-	3	3	12
2.	*Pseudophonus pubescens*	-	-	-	4	-	-	2	-	-	-	-	-	6
3.	*Harpalus distinguendus*	-	-	-	-	-	-	1	-	-	-	-	-	1
4.	*Pterostichus niger*	-	-	-	1	-	-	1	-	-	-	-	-	2
Total 4 species		1	1	2	6	1	0	6	2	1	0	3	3	26
V2 - 22.06.2022														
	Pterostichus cylindricus	1	1	1	2	4	3	1	1	2	-	1	-	17
2.	*Pseudophonus pubescens*	-	-	-	-	-	1	2	1	-	-	-	-	4
3.	*Pseudophonus griseus*	-	-	-	-	-	-	3	1	-	-	-	-	4
4.	*Pterostichus niger*	3	-	-	-	-	1	1	1	-	-	-	-	6
5.	*Calatus fuscipes*	-	-	-	-	-	-	-	2	-	-	-	-	2
Total 5 species		4	1	1	2	4	5	7	6	2	0	1	0	33
V2 - 10.07.2022														
	Pseudophonus pubescens	-	-	-	-	-	-	3	-	-	-	-	-	3
2.	*Pterostichus cylindricus*	2	1	-	-	3	1	2	3	-	1	2	1	16
Total 2 species		2	1	-	-	3	1	5	3	-	1	2	1	19
V2 - 24.07.2022														
	Pterostichus cylindricus	2	2	-	2	-	2	1	-	-	-	-	-	9
2.	*Pseudophonus pubescens*	1	1	-	-	-	-	3	2	1	1	2	1	12
3.	*Pseudophonus griseus*	-	-	-	-	-	-	-	-	-	1	-	-	1
4.	*Zabrus tenebrioides*	-	-	-	-	-	-	-	1	-	-	-	-	1
Total 4 species		3	3	0	2	0	2	4	3	1	2	2	1	23
V2 - 07.08.2022														
	Pterostichus cylindricus	1	-	1	1	-	-	2	3	-	-	1	-	9
Total 1 specie		1	0	1	1	0	0	2	3	0	0	1	0	9
V2 - 04.09.2022														
	Pterostichus cylindricus	1	-	2	-	-	-	1	-	-	-	-	1	5

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2.	*Pterostichus niger*	-	-	1	-	-	-	-	-	1	-	1	1	4
3.	*Pseudophonus pubescens*	-	-	1	-	-	-	-	-	-	-	-	-	1
4.	*Pseudophonus griseus*	-	-	-	-	-	-	-	-	-	-	-	1	1
Total 4 species		1	0	4	0	0	0	1	0	1	0	1	3	11
V2 - 18.09.2022														
	Pterostichus cylindricus	1	-	-	-	-	-	2	1	-	-	-	-	4
2.	*Pterostichus niger*	-	-	-	-	-	-	-	1	-	-	1	-	2
Total 2 species		1	0	0	0	0	0	2	2	0	0	1	0	6

The species with the highest number of specimens in both variants were *Pterostichus cylindricus* and *Preudophonus pubescens*.

During the VII harvest carried out on August 7, 2022, 15 carabid specimens belonging to a number of species were collected in the ecological version (V1), while 9 carabid specimens were collected in the conventional version (V2). The species with the largest number of specimens in both variants was *Pterostichus cylindricus*.

During the VIII harvest carried out on August 21, 2022, 20 carabid specimens belonging to a number of 4 species were collected in the ecological version (V1), while 16 carabid specimens were collected in the conventional version (V2), belonging to a number of 3 species. The species with the largest number of specimens in both variants was *Pterostichus cylindricus*.

During the 9th harvest carried out on September 4, 2022, 16 carabid specimens belonging to a number of 4 species were collected in the ecological version (V1), while 11 carabid specimens were collected in the conventional version (V2) belonging to a number of 4 species.

During the harvesting of X carried out on September 18, 2022, 9 specimens of carabid belonging to a number of species were collected in the ecological version (V1), while in the conventional version (V2), 6 specimens of carabid were collected belonging to two species.

Regarding the structure, dynamics, and abundance of the species collected throughout the observation period, the situation is as follows:

In the ecological version (V1), 501 specimens belonging to a total of 16 species were collected.

The species with the highest number of specimens in both variants were *Preudophonus pubescens* with 240 specimens, followed by *Pterostichus cylindricus* with 117 specimens and *Pterostichus griseus* with 97 specimens collected.

The species *Amara similata*, *Platynus assimilis*, *Harpalus aeneus*, *Leistus ferrugineus* and *Bembidion ruficorne* had the lowest number of specimens, one each.

In the conventional version (V2), 243 specimens belonging to a number of nine species were collected. The species with the largest number of specimens collected were *Pterostichus cylindricus*, with 140 specimens and *Pseudophonus pubescens*, with 60 specimens. A number of species had only one specimen each; they were *Zabrus tenebrioides* and *Abax carinatus*.

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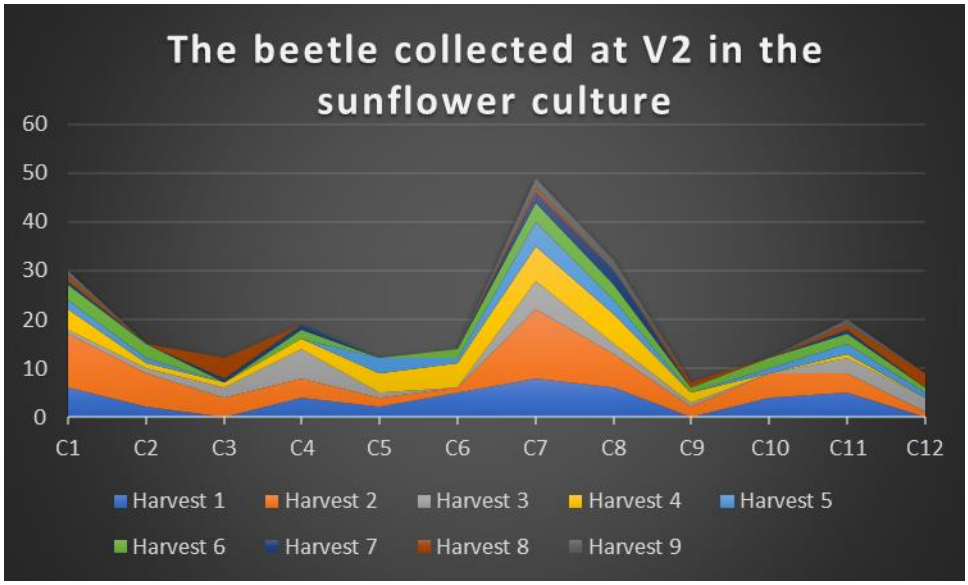

Figure 4. The beetles cillected at V21 in the sunflower culture

Variations are observed in the number of individuals harvested for each species over different time periods.

Some species show clear trends in increasing or decreasing the number of individuals harvested over time (Figure 4). For example, *Pseudophonus pubescens* appears to have a significant increase between the 15.05.2022 and 29.05.2022 harvests, but then declines in the 12.06.2022 harvest. *Pterostichus cylindricus* and *Pseudophonus pubescens* appear to be among the most harvested species in several harvests.

There appears to be significant variation in the number of individuals collected in each collection set. For example, in harvest 2 and harvest 4, the number of individuals is higher compared to the other harvests, while in harvest 3 and harvest 5, the number appears to be lower. These fluctuations could be influenced by several factors, such as weather conditions, habitat, and other ecological variables.

4. CONCLUSIONS

Collecting carabids in different collection sets and at different time periods demonstrates their variation according to ecological and seasonal factors. This variation underlines the importance of continuous monitoring for understanding population dynamics and the impact of environmental changes on them.

Certain species, such as *Pterostichus cylindricus* and *Pseudophonus pubescens*, are more abundant and common in collections, while others are rarer and less common. This emphasizes the diversity of species and the need to protect the habitat and ecological conditions that support this diversity.

Trends are observed in the increase or decrease in the number of individuals collected for certain species over time. These fluctuations can be influenced by factors such as climate change, habitat disturbances, or complex interactions between different species.

The collected data underscore the importance of habitat conservation and healthy ecosystems for the survival and well-being of carabid populations. Protection of natural habitats and their proper management are essential for maintaining biodiversity and ecological functions.

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There is a continuing need for research to better understand the dynamics of carabid populations and the impact of environmental change on them. This understanding can contribute to the development of more effective conservation and habitat management strategies.
Overall, the analysis of carabid collection data provides valuable information about the diversity and dynamics of these insects and highlights the importance of conservation and appropriate management of their natural habitats.
By applying treatments to the vegetation, such as Attribut 70 and Elumis, the risk of damage from pests and diseases can be reduced, which can lead to a better and more consistent crop.
In conclusion, treatments applied to seeds and vegetation have a crucial role in protecting agricultural crops against pests and diseases, contributing to obtaining a healthy and quality harvest. Using the right chemicals and following application instructions are essential to ensuring the effectiveness of these treatments and minimizing their impact on the environment and human health.
Comparing the two variants, we can see that variant 1 records a greater diversity of harvested species in the first four harvests, and then this diversity drops steeply in the last five harvests. On the other hand, variant 2 shows a lower initial diversity but is relatively constant throughout the harvests.

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