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THE BIODIVERSITY OF COLEOPTERO-FAUNA FROM WHEAT CROPS IN THE CONDITIONS OF THE NEW CLIMATE CHANGES AND THE PREMERGING PLANT

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Abstract

The observations were made in a wheat crop located in NE Moldova, Romania. In characterizing the climate in the NE of Moldova, we rely on long-term meteorological observations from the Plant Protection Center. In order to achieve the research objectives, were used three experimental variants:1st variant, wheat after wheat; 2nd variant, wheat after sun flower; 3rd variant, wheat after corn. In wheat crops, 43 harmful species were reported, grouped into 3 categories: species that caused damage with an attack rate of 3-20%, even if chemical treatments were performed, species that produced a sporadic attack, under 1% and species reported only in cereal crops without causing damage. A new concept has emerged, namely integrated control, which can be defined as a form of applied ecology, dividing pest populations, predator and parasite populations on the other in agrobiocenosis.

Key words*: biodiversity, wheat, Barber traps.*

INTRODUCTION

Beetles (order Coleoptera) are the group with the largest number of insects in terms of species abundance, with about 400,000 species described (Jäch M.A. and Balke M. 2008) and divided into 211 families (Cesar J. Benetti et al., 2018).
The vast majority of species are terrestrial and only a small percentage can be considered aquatic. Due to this, the Coleoptera is one of the largest orders of aquatic invertebrates (Cesar J. Benetti et al., 2018).
No element satisfies human requirements as economically nutritious and active as wheat bread. Wheat is rich in the protein (7-22%) which is represented by protamine (35-45%); glutamine (35-40%); globulins (15-20%) and albumin (2.5%). All of these ensure the growth and development of the body and play a very important biocatalytic and energetic role (Gîdei and Popescu, 2009).
The large number of the pests that attack wheat crops make the organization of their control occupy an important volume of the concerns of farmers.
In recent years, technologies to control wheat pests have registered methodological recommendations related to the impact of climate change on the structure and attack of pests (Malschi et al., 2018), (Gîdei and Popescu, 2009) as well as the practice of the system of minimum soil works, without plowing, adequate for soil protection and conservation of soil water supply, in drought conditions (Carlier L. et al., 2006; Herbert et al., 2007).
Pest control should be applied in conjunction with integrated pest management, which consists of a pest management set and uses a balanced approach to all control methods (agro-phytotechnical, physical-mechanical, biological and chemical) to maintain the ratio. of pests or their attack at a level where no significant crop losses occur.
This integrated control system is a conglomeration of methods, means and products that are applied according to different classification principles in crop technology to reduce damage.
In order to control it is necessary to take into account of the taxonomic studies (determination of host and parasite species), biology studies (food source, mode of attack and feeding, stages of development, duration of each stage, mode of multiplication, number of generations, etc.),

ecology studies (influence of climatic factors, establishing the relationship between the attacked species and the pest, establishing the relationship between pests and parasitic species, the importance of parasites in limiting the pest population) (Neculiseanu, 2000).
These studies refer to the possibility of controlled human intervention, in order to reduce damage and restore biocenotic balances in ecosystems and which will form the basis for the development of biological and integrated pest control schemes.

MATERIALS AND METHODS

The informations from this paper were obtained from observations made in the period 2020-2021 in a wheat crop located in the NE part of Moldova.
In order to evaluate the potential of the available agro-climatic resources, were taken into account of the agrometeorological data registered with the Agroexpert system. By constantly monitoring and supervising the phenomen of risk / thermal and water stress, the most effective measures can be applied to prevent and reduce the negative effects on the wheat crop.
Collection of entomological material using soil traps type Barber. Soil traps type Barber consisted of inserting 500 ml plastic boxes with of 10 cm in diameter and 8 cm a height of buried in the ground into the soil, in which a solution of formalin (40%) diluted with water was placed up to a concentration of 5%. The pits were made with a spade, and the boxes were buried very carefully so that the edge of the trap was at ground level so that the insects would not be hindered by any obstacle in its vicinity (Varvara et al., 1991) (Figure 1).
The traps were installed at a distance of about 6 m between them. The number of Barber soil traps used to obtain the most accurate data was determined by the location of the collection, ranging from 15 to 50 (Diaconica, 2019).

Figure 1. Installing traps in experimental lots

The experience was organized in 3 variants:
- V1 wheat after wheat;
- V2 wheat after sunflower;
- V3 wheat for corn.

The location of the traps was made in a row with 6 traps per variant, at a distance of 6 m between them. The samples were collected in each of the two years of observation (2020 and 2021) during April-August, at intervals of about 7-10 days.
At each harvest, the contents of the box were wrapped in gauze, and each sample was labeled with the date of collection, the trap number and the variant (Figure 2).

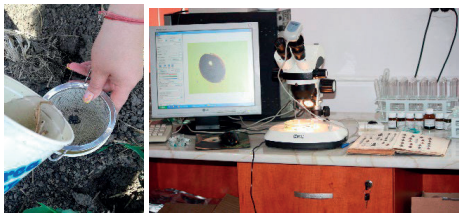

Figure 2. The gathering and determination of the collected material (original)

In the laboratory, the material was cleaned of plant debris and then washed under running water. The material was selected by order or species, and the insects were determined using the determinant (Gîdei 2009; 2012).
Following the identification of harmful species in the crops studied, a series of indicators such as frequency, intensity and degree of attack were followed.
The *attack frequency* (F %), which represents the ratio between the number of attacked plants or plant organs analyzed and is calculated according to the formula: $F\,\% = \frac{n}{N} \times 100$
The *intensity of the attack* (I %), actually represents the percentage of plants, or of attacked organs of the plant destroyed by the pest.
Depending on this scale, the *attack intensity* (I %) is calculated according to the formula:

$$I\,\% = \frac{\sum (i \times f)}{n}$$

The degree of attack (GA) is equal to the product of these two indicators.

$$GA = \frac{F\% \times I\%}{100}$$

RESULTS AND DISCUSSIONS

The climate of the area is part of the temperate continental climate with regions of steppe.
It is an essential ecosystem component in the appearance and development of this region, being of temperate continental type, with moderate-continental (Central European) nuance at the level of the high hills and excessively continental (Eastern European).
In our research, the climate component has a very important role, both in the biology of insects in the agricultural ecosystem and in the phenology of crop plants.
The average temperature (Figure 3) of the agricultural year 2020-2021 is comparable to the multiannual one, but during the vegetation period the values of the average temperatures recorded in the air were lower than the normal values, due to the high amplitude between the temperature during the day and night.

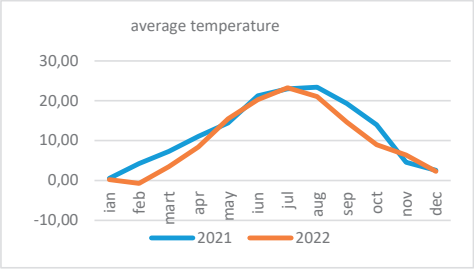

Figure 3. The average temperature of the agricultural year 2020-2021

The annual water regime (Figure 4) is surplus compared to the normal one, but during the vegetation period the sum of the registered precipitations satisfies the necessity of the wheat crop.
The trend of rainfall characteristics is the presence of torrential rains, the increase of the number of rains greater than 0.1 mm and less than 5.0 mm and the decrease of the number of recoverable rains (> 5 mm). Knowledge of agro-meteorological characteristics is necessary in establishing the trend of thermal and water risk on wheat crops.
In 2021, the Phytosanitary Office issued two warnings on 29.04. and 18.05.2021, regarding the control of foliar diseases and pests of wheat crops.

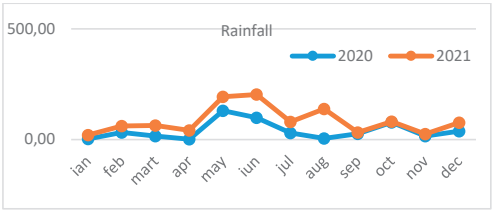

Figure 4. The annual water regime in year 2020-2021

In 2020, two warnings were issued on 06.04. and 21.05.2020, by the Phytosanitary Office, regarding the control of foliar diseases and pests of wheat crops.
For the control of foliar diseases: *Erysiphe graminis, Puccinia* spp., *Septoria tritici, Fusarium* spp., It is recommended to use Priaxor EC, Topsin 500 SC, Nativo PRO 325 SC, Evolus, Mystik PRO, Protector Super 250 EC Karate Zeon, Fastac Active, Priaxor EC, Biscaya 240 OD and Orius 25 EW.

Figure 5. Aspects of the presence and attack of harmful species in wheat culture

For the control of foliar diseases: *Erysiphe graminis, Puccinia* spp., *Septoria tritici, Fusarium* spp., it is recommended to use the products Priaxor EC, Nativo PRO 325, Mystik PRO and to control the pests of cereals Alfametrin 10 EC, Mavrik 2 F, Karate Zeon, Evolus, Priaxor EC, Orius 25 EW.
The species that caused some damage with an attack rate of between 3-30%, even if some treatments were performed. *Eurygaster* spp., *Aelia* spp., *Opatrum sabulosum, Otiorrhynchus pinastri, Epicometis hirta, Phyllotreta nemorum, Phyllotreta vittula, Zabrus tenebrioides and Haplotrips tritici* had the highest attack rate.
- species that have produced a sporadic attack, less than 1%, such as: *Pseudophonus rufipes, Selatosomus latus, Dorcadion fulvum, Otiorrhynchus lingustici, Selatosomus bipustulatus, Atomaria linearis, Harpalus tardus, Phyllotreta atra, Otiorrhynchus raucus, Harpalus distinguendus*.
- species reported only in cereal crops without causing damage, among which we mention:

Pedinus femoralis, Pseudophonus griseus, Aphthona euphorbiae, Pentodom idiota, Apion tenue, Apion urticarium, Apion virens, Ceutorrynchus scapularis, Dorcadion pedestre, Longitarsus pratensisetc.

Tabel 1. Pests reported during the wheat crop research period

Scientific name	Order / Family	Observations
Eurygaster spp.	Heteroptera /Scutelleridae	7-10 % attack
Aelia spp.	Heteroptera /Pentatominae	3-5 % attack
Opatrum sabulosum	Coleoptera /Tenebrionidae	15-20% attack
Otiorrhynchus pinastri	Coleoptera /Curculionidae	10-15% attack
Epicometis hirta	Coleoptera /Cetoniidae	7-10 % attack
Phyllotreta nemorum	Coleoptera /Chrysomelidae	3-5 % attack
Tanymecus dilaticollis	Coleoptera /Curculionidae	10-30% attack
Lema melanopa	Coleoptera/Chrysomelidae	7-10% attack
Anisoplia segetum	Coleoptera/Rutelidae	8-15% attack
Zabrus tenebrioides	Coleoptera /Carabidae	5-8% attack
Phyllotreta vittula	Coleoptera /Chrysomelidae	2-3% attack
Haplotrips tritici	Thysanoptera /Phlaeothripinae	15-20% attack
Agriotes lineatus	Coleoptera /Elateridae	9-11% attack
Pseudophonus rufipes	Coleoptera/Carabidae	Signaled
Selatosomus latus	Coleoptera/Elateridae	Signaled
Dorcadion fulvum	Coleoptera/Cerambycidae	Signaled
Otiorrhynchus lingustici	Coleoptera/Curculionidae	Signaled
Harpalus distinguendus	Coleoptera /Carabidae	Signaled
Atomaria linearis	Coleopter/Cryptophagidae	Signaled
Harpalus tardus	Coleoptera/Carabidae	Signaled
Phyllotreta atra	Coleoptera /Chrysomelidae	Signaled
Otiorrhynchus raucus	Coleoptera/Curculionidae	Signaled
Selatosomus bipustulatus	Coleoptera/Elateridae	Signaled
Pedinus femoralis	Coleoptera/Tenebrionidae	Sporadic
Pseudophonus griseus	Coleoptera/Carabidae	Sporadic
Aphthona euphorbiae	Coleoptera/Chrysomelidae	Sporadic
Pentodom idiota	Coleoptera /Dynastidae	Sporadic
Apion tenue	Coleoptera/Curculionidae	Sporadic
Apion urticarium	Coleoptera/Curculionidae	Sporadic
Apion virens	Coleoptera/Curculionidae	Sporadic
Ceutorrynchus scapularis	Coleoptera/Curculionidae	Sporadic
Dorcadion pedestre	Coleoptera/Cerambycidae	Sporadic
Longitarsus pratensis	Coleoptera /Chrysomelidae	Sporadic
Malachius marginellus	Coleoptera/Melyridae	Sporadic
Otiorrhynchus fuscipes	Coleoptera/Curculionidae	Sporadic
Otiorrhynchus laevigatus	Coleoptera/Curculionidae	Sporadic
Bruchus affinis	Coleoptera /Chrysomelidae	Sporadic
Oscinella frit	Diptera /Chloropidae	Sporadic
Chlorops pumilionis	Diptera /Chloropidae	Sporadic
Phorbia securis	Diptera/Anthomyiidae	Sporadic
Mayetiola destructor	Diptera/Cecidomyiidae	Sporadic
Schizaphis graminum	Hemiptera /Aphididae	Sporadic
Delia coarctata	Diptera/Anthomyiidae	Sporadic

From the analysis of the entomofauna dynamics of beetles collected in 2020 in the three experimental variants, a large variation of the number of species and individuals is found from one collection to another (Tabel 2).

Table 2. The abundance of beetle species collected in 2020 in wheat culture

Variant	Rec. I 29.04	Rec. II 17.05	Rec. III 29.05	Rec. IV 13.06	Rec. V 27.06	TOTAL
V1	252	194	94	60	49	649
V2	360	158	56	40	33	647
V3	253	315	67	39	96	770
	865	667	217	139	178	2066

The largest number of individuals was collected in April, at the first harvest of variant V2, wheat after sunflower, when were gathered 360 beetles. The fewest specimens, 33 in number, were collected at the aVa harvest, also at V2 (Figure 6).

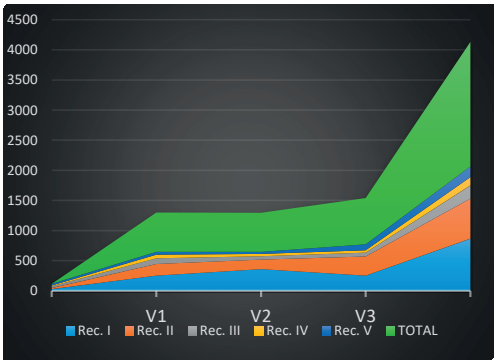

Figure 6. Analysis of the entomofauna dynamics of beetles collected in 2020

From the analysis of the entomofauna dynamics of beetles collected in 2021 in the three experimental variants, we find a large variation in the number of species and individuals, from one collection to another (Table 3).

Tabel 3. The abundance of beetle species collected in 2021 in wheat culture

Variant	Rec. I 24.05	Rec. II 30.05	Rec. III 07.06	Rec. IV 18.06	Rec. V 22.06	Rec. VI 06.07	Rec. VII 02.08	TOTAL
V1	232	165	165	129	77	102	50	920
V2	120	132	186	70	44	52	31	635
V3	166	132	161	89	126	78	23	775
	518	429	512	288	247	232	104	2330

The largest number of individuals was collected in May, at the first harvest of variant V1, wheat after wheat, when was gathered 232 of beetles. The fewest specimens, 23 in number, were collected at the 7th harvest on 02.08, in the variant wheat after corn (Figure 7).

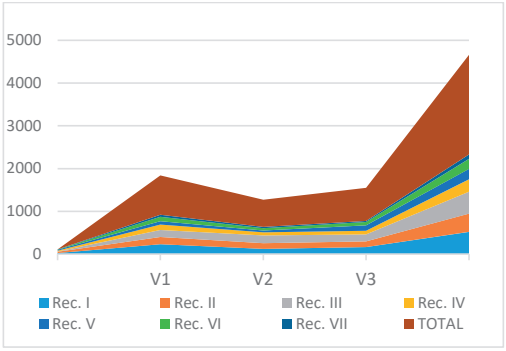

Figure 7. Dynamics of the beetle species collected in 2021

The beetle species were divided into 3 categories taking into account the food they consume, as follows:
- useful species - predators, which feed on insects or other invertebrates;
- species - harmful to some cultivated plants;
- species of beetles that do not cause damage, but have a phytophagous food regime.
Following the analysis of the collected material, in connection with the mode of feeding, the situation in the research year 2020 is as follows (Tables 4, 5, 6):
- 29 species, totaling 826 specimens of beetles are cited in the literature as harmful, representing 40%.
The most commonly encountered were: *Epicometis hirta* (187 specimens), *Opatrum sabulosum* (179 specimens), *Phyllotreta nemorum* (135 specimens), *Pentodon idiota* (91 specimens), *Tanymecus dilaticollis* (44 specimens) (Tabel 4).
- the useful species of beetles collected (28) totaled 626 specimens, representing 30.3% of the total. The most commonly encountered were: *Conosoma bipunctata* (279 specimens), *Pterostichus marginalis* (265 specimens), *Colodera nigrita* (53 specimens), *Coccinella 7 punctata* (18 specimens) (Tabel 5).

Coccinella 7 punctata is a shock predatory carabid found in cereal crops, causing medium, equal to or less than degrees of aphids, such as those caused by chemical treatments.
Harpalus aeneus feeds on eggs and larvae of larvae, eggs and larvae of firing beetles and other insects.
Pterosthichus nigrita has adults and larvae predators of the larvae and pupae of the flower mosquito of wheat flowers.
Anthicus floralis has omnivorous adults, consuming small arthropods, pollen, fungi and anything else they can find. Some species are cited in the literature as biological control agents because they may eat eggs or larvae of pests.
- 38 species (617 specimens) of beetles are designated as non-harmful, representing 29.7%. Among them, the most numerous were: *Drasterius bimaculatus* (146 specimens), *Dermestes laniarius* (107 specimens), *Formicomus pedestris* (100 specimens), *Anthicus antherinus* (83 specimens) and *Pteryngium crenatum* (79 specimens) (Tabel 6).

Tabel 4. Harmful beetle species in wheat crops in 2020

Name	Number of specimens/Variant		
	1	2	3
Epicometis hirta	58	111	18
Opatrum sabulosum	73	70	36
Phyllotreta nemorum	21	108	6
Pentodon idiota	33	40	18
Tanymecus dilaticollis	20	15	9
Harpalus distinguendus	16	10	7
Agriotes lineatus	11	9	12
Pedinus femoralis	23	6	-
Phyllotreta atra	-	17	5
Phyllotreta nodicornis	-	17	5
Aphthona euphorbiae	10	-	2
Otiorrhynchus laevigatus	6	2	1
Orchestes fagi	7	-	-
Pseudophonus rufipes	6	-	-
Harpalus tardus	4	2	-
Pseudocleonus cinereus	2	3	-
Anobium punctatum	-	5	-
Tanymecus palliatus	-	-	5
Blaps mortisaga	2	1	1
Stomodes gyrosicollis	-	3	-
Ceutorhynchus punctiger	2	-	-
Cassida nobilis	2	-	-
Otiorrhynchus singularis	2	-	-
Zabrus blapoides	1	1	-
Paradons quadrisignatus	-	-	2
Anisoplia segetum	1	-	-
Oulema melanopa	-	1	-
Selatosomus latus F	-	-	1
Zabrus tenebrioides	-	-	1
TOTAL 29 species and 823 samples	823		

Tabel 5. Useful beetle species identified in wheat crops in 2020

Name	Variant		
	1	2	3
Conosoma bipunctata	11	4	264
Pterostichus marginalis	3	3	259
Colodera nigrita.	10	28	15
Coccinella 7 punctata	12	5	1
Ityocara rubens	1	-	12
Microletes maurus	-	7	5
Metabletus truncatelus	5	5	-
Idiochroma dorsalis	1	-	8
Brachynus explodens	-	-	6
Pterostichus lepidus	3	-	-
Anisodactylus binotatus			3
Calathus fuscipes	-	1	2
Pterostichus aterrimus var. niger	1	1	-
Coccinulla quatuordecimpustulata sinensis Wse	2	-	-
Pterostichus cupreus	-	1	1
Sipalia circularis	-	1	1
Calosoma inquisitor	1	-	-
Necrophorus antennatus	1	-	-
Callistus lunatus	1	-	-
Cypticus quisquilius	1	-	-
Broscus cephalotes	1	-	-
Coccinella 5 punctata	1	-	-
Staphylinus caesareus	-	1	-
Astenus filiformis	-	1	-
Hister quadrimaculatus	-	-	1
Tachyusa constricta	-	-	1
Paederus limnophilus	-	-	1
Metabletus foveatus	-	-	1
TOTAL 28 species and 626 samples		626	

Tabel 6. The beetle species collected in 2020 that do not cause damage to the crop plants

Name	Variant		
	1	2	3
Drasterius bimaculatus	115	31	-
Dermestes laniarius	28	19	60
Formicomus pedestris	41	22	37
Anthicus antherinus	13	57	13
Pteryngium crenatum	8	9	62
Anthicus floralis	5	5	31
Pleurophorus caesus	4	8	14
Cryptophagus dentatus	21	-	-
Tachyporus ruficolis	3	-	15
Anthicus humeralis	13	-	4
Silpha obscura	-	1	12
Anthicus gracilis	11	-	-
Hypnoidus pulchellus	4	5	1
Oxyporus rufus	9	-	-
Amara aenea	1	4	2
Cercyon lateralis	-	-	7
Anthicus humilis	6	-	-
Corticaria longicornis	3	-	3
Cartodere ruficollis	-	-	6
Ophonus sabulicola	-	-	4
Cetonia aurata	2	-	1
Harpalus smaragninus	-	-	3
Paramecosoma melanocephalum	-	-	3
Amara eurynota	-	-	3
Aphodius fimetarius	-	2	-
Cantharis fusca	-	-	2
Anthicus quadriguttatus	-	-	2
Onthophagus taurus	-	1	-
Mycetophagus populii	-	1	-
Psammobius porcicollis	-	1	-
Ophonus azureus	-	-	1
Atomaria fuscicollis	-	-	1
Bidessus geminus	-	-	1
Harpalus cupreus	-	-	2
Scirtes hemisphaericus	-	-	1
Cryptophagus dorsalis	-	-	1
Cerylon ferrungineum	-	-	1
Melanotus brunnipes	-	-	1
TOTAL 38 species and 617 samples		617	

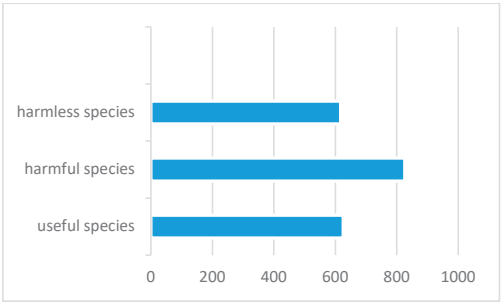

Figure 8. The number of copies of beetles collected in 2020 according to their food spectrum

In the research year 2021, from the investigation of the collected material, depending on the mode of feeding, the situation is as follows (Tables 7, 8, 9):

- a number of 32 species totaling 970 specimens of beetles are cited in the literature as harmful, representing 41.6%.

The most abundant species were: *Opatrum sabulosum* (493 specimens), *Otiorrhynchus pinastri* (305 specimens), *Pentodom idiota* (30 specimens), *Otiorrhynchus orbicularis* (26 specimens), *Harpalus distinguendus* (24 specimens), *Agriotes ustulatus* (17 specimens). (Tabel 7).

- there were 28 useful beetle species collected, with a total of 338 specimens, representing 14.5% of the total. The most abundant species were: *Idiochroma dorsalis* (87 specimens), *Coccinella 7 punctata* (55 specimens), *Conosoma bipunctatum* (48 specimens), *Pterostichus cupreus* (21 specimens), *Metabletus truncatelus* (12 specimens), *Micraspis 12 punctata* (12 specimens) (Tabel 8);

- a number of 34 species totaling 1022 specimens of beetles are cited in the literature as being non-harmful, representing 43.8%. Among these, the most abundant were: *Dermestes laniarius* (512 specimens), *Formicomus pedestris* (208 specimens), *Anthicus humilis* (82 specimens), *Anthicus floralis* (72 specimens) and *Pteryngium crenatum* (65 specimens) (Tabel 9).

According to agricultural science, the choice of a good precursor plant can increase the production by 50 percent more than monoculture (Figure 10).

Tabel 7. Harmful beetle species identified in wheat crops in 2021

Name	Variant		
	1	2	3
Opatrum sabulosum Linnaeus	237	104	152
Otiorrhynchus pinastri Herbst.	93	87	125
Pentodom idiota Hbst.	7	13	10
Otiorrhynchus orbicularis Herbst	5	7	14
Harpalus distinguendus Duftscmid	16	5	3
Agriotes ustulatus Schaller	3	4	10
Epicometis hirta Poda	7	3	1
Tanymecus dilaticollis Gyll	-	2	9
Harpalus aeneus Fabricius	6	1	2
Agriotes lineatus Linnaeus	2	3	1
Aelia spp Linnaeus	4	-	-
Dorcadion fulvum Scopoli	-	1	2
Otiorrhynchus lingustici Linnaeus	-	1	2
Otiorrhynchus raucus Fabricius	1	-	2
Pseudophonus griseus Panzer	2	-	1
Atomaria linearis Stephens	-	-	2
Harpalus tardus Panzer	1	-	1
Phyllotreta atra Fabricius	2	-	-
Phyllotreta vittula Redtenbacher	2	-	-
Zabrus tenebrioides Goeze	-	2	-
Aphthona euphorbiae Schrank.	1	-	-
Apion tenue Herbst.	1	-	-
Apion urticarium Herbst.	-	-	1
Apion virens Herbst	-	-	1
Ceutorrynchus scapularis Germar	-	-	1
Dorcadion pedestre Poda	-	1	-
Longitarsus pratensis Panzer	1	-	-
Malachius marginellus Fabricius	-	-	1
Otiorrhynchus fuscipes Stierlin & W.G.	1	-	-
Otiorrhynchus laevigatus Latreille	-	-	1
Pseudophonus rufipes De Geer	1	-	-
Selatosomus bipustulatus Linnaeus	-	-	1
TOTAL 32 species and 970 samples		970	

Tabel 8. Useful beetle species identified in wheat crops in 2021

Name	Variant		
	1	2	3
Idiochroma dorsalis Pontoppidan	11	13	63
Coccinella 7 punctata Linnaeus	20	16	19
Conosoma bipunctatum Grav.	10	16	22
Pterostichus cupreus Linnaeus	6	3	12
Metabletus truncatelus Linnaeus	4	2	6
Micraspis 12 punctata Linnaeus	5	4	3
Crypticus quisquillius Linnaeus	3	8	-
Hister stercorarius Hoff.	1	2	3
Carabus coriaceus Linnaeus	4	-	1
Anisodactilus binotatus Fabricius	1	-	3
Calathus fuscipes Goeze	2	-	2
Carabus cupreus Linnaeus	-	2	1
Pterosthichus nigrita Paykull	2	-	1
Anisodactilus signatus Dejean	2	-	-
Cymindis axillaris Fabricius	-	-	2
Exosoma lusitanicum Linnaeus	-	2	-
Abax ovalis Duftschmid	1	-	-
Carabus crenatus Duftschmid	-	1	-
Cicindela campestris Linnaeus	-	1	-
Cynegetis punctata Linnaeus	-	1	-
Harpalus calceatus Duftschmid	-	-	1
Hister bimaculatus Gyll	-	1	-
Metabletus obscuroguttatus Duftschmid	-	1	-
Platynaspis luteorubra Goeze	-	-	1
Scopaeus laevigatus Gyllenhal	1	-	-
Stilicus angustatus Gravenhorst	-	1	-
Tachinus subterraneus Linnaeus	1	-	-
Zyras collaris Markel.	-	-	1
TOTAL 28 species and 338 samples		338	

Tabel 9. The beetle species collected in 2021that do not cause damage to the crop plants

Name	Variant		
	1	2	3
Dermestes laniarius Illiger	213	187	112
Formicomus pedestris Rossi	88	57	63
Anthicus humilis Germar	45	20	17
Anthicus floralis Linnaeus	34	18	20
Pteryngium crenatum Fabricius	24	11	30
Letrus apterus Laxmann	3	2	3
Harpalus azureus Duft.	1	3	3
Pleurophorus caesus Panzer	-	3	4
Zabrus blapoides Creutzer	1	3	3
Amara eurynota Panzer Panzer	-	2	3
Ophonus azureus Fabricius	3	1	1
Podonta nigrita Fabricius	-	1	4
Amara aenea De geer	4	-	-
Anthicus quadriguttatus Rossi	-	4	-
Cetonia aurata Linnaeus	1	1	2
Tachysa constricta Linnaeus	1	2	-
Bidessus unistriatus Schrank	-	1	1
Cantharis fusca Linnaeus	1	-	1
Cartodere ruficollis C. G. Thomson	-	1	1
Otho spondiloides	1	-	1
Philontus speldens Steph.	-	1	1
Silpha obscura Linnaeus	1	-	1
Atomara turgida Reitter	-	1	-
Combocerus glaber Schaller	-	-	1
Cryptophagus subdepressus Gyll.	-	1	-
Dolichosoma lineare Rossi	-	-	1
Hypnoidus pulchellus Linnaeus	-	-	1
Medon obsoletus Nordmann	1	-	-
Ophonus obscurus Fabricius	1	-	-
Oxypora annularis	1	-	-
Oxypora vittata	-	-	1
Poecilus dimidiatus G.A.Olivier	1	-	-
Quedius cruentus Olivier	-	-	1
Quedius molochinus Grav.		1	
TOTAL 34 species and 1022 samples		1022	

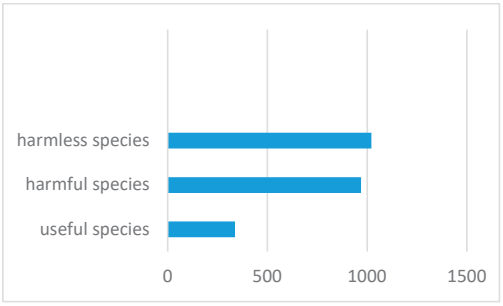

Figure 9. The number of copies of beetles collected in 2021 according to their food spectrum

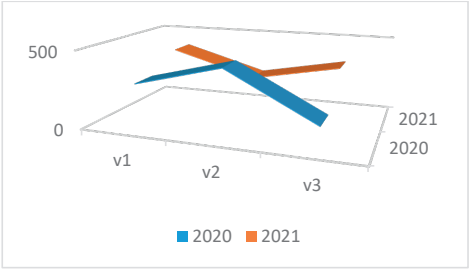

Figure 10. Species of harmful beetles identified in the wheat crop during the research period, depending on the precursor plant

CONCLUSIONS

Wheat and corn also have common diseases that we must take into account. Wheat after wheat crop can only be applied for one year, so we risk multiplying the diseases and pests of wheat, which then creates the major problems of declining production, or to combat chemicals, repeated work and chemical pollution. The advantage of wheat in a single year is that, when harvested in the summer, it allows soil work to be carried out, chemical fertilizers can be applied and weeds can be controlled.

Wheat growing in rotation with corn is also required for economic reasons. Thus, the total production of wheat and corn grown in rotation cannot be matched by any other pair of wheat with another plant.

However, wheat cannot be sown after maize if a large amount of Atrazine-based herbicide has been used in maize cultivation (more than 3 kg/ha; Atrazine has a residual negative effect on wheat).

Sunflower is a poor precursor to wheat, due to the fact that it impoverishes the soil in nutrients and water, which makes the preparation of the land difficult and of inferior quality.

If it is harvested on time and as soon as possible, the crop has been well maintained by the plowshares, plowed deep and fertilizers are used, sunflower can become a good precursor for wheat.

Because during the research period, in variant V2, wheat after sunflower, the number of harmful species is the lowest (16 species), compared to V1 and V3 when a higher number of harmful species were collected (20 and 18 species respectively), we recommend the use in practice of the wheat variant after sunflower.

As the greatest diversity in terms of the abundance of species collected was also recorded in the V2 wheat variant after sunflower, we recommend this variant in agricultural practice.

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