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Short Communication

Biodiversity of epigeic groups – ecological vs integrated management system

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The aim of the study was to evaluate the impact of an ecological and an integrated management systems within the cultivated crops of *Hordeum vulgare*, *Pisum sativum*, *Vicia faba* with *Medicago sativa* on the biodiversity of epigeic groups, in the Nitra-Dolná Malanta location, during the years 2019 and 2020, using the ground trap method. 27,987 specimens of the epigeic group of animals were obtained, 15,654 in the ecological system and 12,333 were in the integrated management system. Evertebrates belonged to 23 orders, 1 order Vertebrata and 1 undetermined group Larvae. Coleoptera, Collembola, Acarina, Formicoidae, Araneida had dominant occurrence. Subdominant representation was recorded in Opilionida. Recedent, or the subrecedent occurrence of Auchenorrhyncha, Heteroptera, Chilopoda, Isopoda, Lumbricidae and others was confirmed, which contributed to the biodiversity of the agroecosystem. Grown crops *Pisum sativum* and *Hordeum vulgare* showed the highest abundance, *Vicia faba* with *Medicago sativa* had the lowest abundance in both management systems. The diversity value in ecological management was 1.9479 and 2.1229 in integrated management. Faunal similarity according to Jaccard, when comparing individual types of management, reached a value of 86.96%. The value for identity of dominance according to Renkonnen was 84.66%. The ecological management system confirmed the suitability of the environmental conditions in terms of the occurrence of epigeic groups, taking into account other factors such as sowing procedure, intensity of management, agro-climatic conditions of the site, but also prevailing intraspecies and interspecies relations.

Keywords: biodiversity, epigeic groups, ecological management, integrated management

1 Introduction

The use of agricultural land and the protection of biodiversity are considered by many scientists to be incompatible. Protection of biodiversity is currently the key challenge, as the benefits of biodiversity protection are difficult to observe in a short time, respectively only from the economic evaluation point of view. Agriculture has a chance to contribute to the protection of ecosystems. However, the interdependence between different groups of organisms, the interaction between human activity and biodiversity require further research (Ivanič Porhajašová et al., 2019). According to Wagg et al. (2014), soil biodiversity is the key resource in terms of ecosystem functioning. The loss of biodiversity is currently a global problem, as the reduction of biodiversity in the soil negatively affects the overall performance of ecosystems. It is necessary to pay attention to the decline of soil biodiversity and to the presence of soil communities. It follows from the aforementioned that the composition of the soil community is the key factor in regulating the functioning of ecosystems. Altieri et al. (2015) state that specific impacts on agricultural production can also be expected in connection with climate change. Surveys from the field indicate that agroecosystems are more flexible than traditional ecosystems. Porhajašová (2011) states the irreplaceability of a wide range of taxonomic groups in the soil, such as Coleoptera, Chilopoda, Collembola, Acarina, Nematoda, Protista and others. Biological soil fertility is little appreciated in any soil management. Edaphic groups represent an important part of terrestrial biodiversity, as they perform important functions in terms of soil fertility in natural ecosystems, or agroecosystems. The negative impact of

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intensive measures on the abundance and diversity of various groups of the epigeic fauna was demonstrated in papers by Baranová et al. (2013) and Badieritakis et al. (2016). Langraff et al. (2018) are of an opinion that the macropterous species of Carabidae (Coleoptera) with a smaller body volume predominate in agroecosystems, which indicates a lower ecological stability of the agricultural landscape. Porhajašová et al. (2012) states that all present edaphic groups are important in terms of maintaining the natural balance and cycle of substances and energy flow in ecosystems.

The role of ecological agriculture is to increase soil fertility by maximizing the efficient use of local resources. Ecological agriculture systems are characterized by greater floristic and faunal biodiversity than conventional systems (Bavec and Bavec, 2015). In the integrated management system, the reduction of maintenance work, the type of vegetation, the soil conditions have an effect on the increase in frequency of edaphic groups. Influence of agricultural management, such as crop harvesting, application of insecticides, herbicides and conventional ploughing, has a significant negative effect on their occurrence, on the contrary, the application of organic fertilizers positively affects the growth of their abundance (Querner et al., 2008). However, if managed properly, integrated systems can improve biodiversity in agricultural areas. In field ecosystems, in addition to natural factors, strong human pressure is also applied. These interventions affect the degree of biodiversity of agroecosystems and are primarily involved in reducing the number of edaphic groups (Porhajašová et al., 2013; Bavec and Bavec, 2015).

In terms of the aim of the study, the attention is focused on evaluating and comparing the impact of the ecological and integrated management systems on the biodiversity of epigeic groups, as the soil environment is a complex of biological communities, it is significantly heterogeneous, which contributes to a wide range of duties, and the present epigeic groups clearly contribute to increasing soil quality and fertility. By their presence, they indicate the topical and trophic conditions of the environment and at the same time serve as part of complex mechanisms, because they react to any changes and inputs in the soil system, including the transport of pollutants, the soil management system and the present vegetation.

2 Material and methods

Collections of biological material were carried within ecological and integrated management system experiments, at the Nitra-Dolná Malanta location, at the experimental research base of the Slovak University of Agriculture in Nitra. The region is located in the southwestern part of the Slovak Republic, its triangular shape is defined by the Tribeč mountain range and the rivers Nitra and Žitava. The location is classified as corn production area, with medium-heavy clay soil, in a warm, slightly dry climate region, it has the character of a plain with a slight inclination to the south, the altitude reaches 177–178 m a. s. l.

The preparation of the soil and the method of establishment of the experiment were always in accordance with the principles of the technology of cultivation of model crops, depending on the method of farming. The model crops were *Hordeum vulgare*, *Pisum sativum*, *Vicia faba* with *Medicago sativa*. Ground traps were exposed in 2019 and 2020, during the growing season (April to October) on the mentioned model crops. Traps were reset regularly at monthly intervals. Within the crops, 2 ground traps were located in a line, which were 10 m apart.

The ground trap methodology is based on the exposure of 1-liter glass bottles, which are embedded at ground level, filled with 4% formaldehyde (approx. 1/3) and protected from above by a roof (Stašiov, 2015). The epigeic material was subsequently preserved in 75% alcohol and it was determined and statistically evaluated at the Institute of Plant and Environmental Sciences.

The presence and biodiversity of epigeic groups was evaluated on the basis of abundance, dominance, species identity according to Jaccard index (I_A), identity of dominance according to Renkonnen (I_D), degree of diversity according to Shannon-Weaver (d), (Losos et al., 1984; Pokorný, 2002; Pokorný and Šifner, 2004).

3 Results and discussion

Soil environment represents the largest complex of biological communities, it is diverse, which contributes to a wide range of services for the soil ecosystem. Cultivation management took place in two agricultural systems, ecological and integrated, in accordance with their established principles. A total of 27,987 specimens (ex) of the epigeic group of animals were obtained using the method of ground traps. Of the mentioned number, 15,654 ex were obtained within the ecological system and 12,333 ex within the integrated management system. There were 23 Evertebrata orders and 1 order Vertebrata order, an undetermined group of Larvae was also present. The presence of epigeic groups within both management systems was almost a mirror image of each other, 22 epigeic groups were present in the ecological system and 21 in the integrated management system (Tables 1, 2). Based on the results, the abundance of the epigeic group of animals was in the favour of the ecological management system, which are characterized

Table 1 Abundance and dominance of epigeic groups at the Nitra-Dolná Malanta site, in the years 2019 and 2020, in selected crops, under ecological farming

Epigeic groups	*Hordeum vulgare*	*Pisum sativum*	*Vicia faba – Medicago sativa*	Total	Dominance (%)
Acarina	704	577	563	1,844	11.78
Araneida	454	539	236	1,229	7.85
Auchenorrhyncha	–	1	1	2	0.01
Coleoptera	1,775	1,566	1,158	4,499	28.74
Collembola	2,195	1,336	973	4,504	28.77
Dermaptera	18	10	30	58	0.37
Diplopoda	71	70	28	169	1.08
Diptera	75	70	97	242	1.57
Isopoda	17	19	24	60	0.38
Formicoidae	378	477	556	1,411	9.01
Heteroptera	40	37	80	157	1.00
Hymenoptera	24	36	24	84	0.55
Chilopoda	16	19	21	56	0.38
Larvae	113	130	160	403	2.57
Lepidoptera	–	–	2	2	0.01
Lumbricida	6	3	7	16	0.10
Muridae	–	1	5	6	0.03
Opilionida	177	205	197	579	3.69
Orthoptera	59	141	123	323	2.06
Siphonaptera	–	1	5	6	0.03
Stylommatophora	–	1	1	2	0.01
Thysanoptera	–	–	2	2	0.01
Total	6,122	5,239	4,293	15,654	100.00

by a larger floristic area and also faunal biodiversity compared to the integrated systems. According to several authors, if integrated systems are managed correctly, they can improve biodiversity in agricultural ecosystems (Ivanič Porhajašová et al., 2019; Bavec and Bavec, 2015).

In both evaluated management systems, the present epigeic groups occurred almost mirror-like. Based on the cumulative abundance, in both types of management within the model crops, an eudominant occurrence of Coleoptera (Ecol. – 4,499 ex = 28.74%; Int. – 2,296 ex = 18.64%), Collembola (Ecol. – 4,504 ex = 28.77%; Int. – 3,234 ex = 26.22%) and Acarina (Ecol. – 1,844 ex = 11.78%; Int. – 1,848 ex = 14.98%). Eudominant, or dominant occurrence was recorded in Formicoidae (Ecol. – 1,411 ex = 9.01%; Int. – 1 874 ex = 15.18%). Dominance was also confirmed in Araneida (Ecol. – 1,229 ex = 7.85%; Int. – 732 ex = 5.95%). Lenoir and Lennartsson (2010) mention Coleoptera, Collembola, Acarina as dominant groups of agroecosystems, which confirms our results. When comparing the integrated management system with the ecological system, it can be concluded that the number of epigeic populations is also affected by the reduction of treatment care.

Opilionida was present subdominantly in the ecological system (579 ex = 3.69%) and dominantly (1,050 ex = 8.51%) in the integrated system. Subdominant representation, i.e. occurrence from 2% to 5% was confirmed only by the undetermined group Larvae. Other minority groups, such as Auchenorrhyncha, Heteroptera, Chilopoda, Isopoda, Lumbricidae and others with an occurrence of less than 1% contributed to the biodiversity of the agroecosystem.

The cultivated crop with properly selected agricultural technology also plays an important role, when evaluating the abundance. The highest abundance in the organic system was recorded for the *Hordeum vulgare* crop (6,122 ex), followed by the *Pisum sativum* crop (5,239 ex), the lowest abundance was recorded for *Vicia faba – Medicago sativa* (4,293 ex). The highest abundance within the integrated system was recorded for the *Pisum sativum* crop (4,870 ex), followed by the *Vicia faba – Medicago sativa* (3,989 ex), the lowest abundance was

Table 2 Abundance and dominance of epigeic groups at the Nitra-Dolná Malanta site, in the years 2019 and 2020, in selected crops, under integrated farming

Epigeic groups	*Hordeum vulgare*	*Pisum sativum*	*Vicia faba – Medicago sativa*	Total	Dominance (%)
Acarina	499	699	650	1,848	14.98
Aphidoidae	5		–	5	0.04
Araneida	229	215	288	732	5.95
Auchenorrhyncha	–	1	–	1	0.01
Coleoptera	728	911	657	2,296	18.64
Collembola	934	1 308	992	3,234	26.22
Dermaptera	13	7	34	54	0.43
Diplopoda	75	27	35	137	1.11
Diptera	59	49	73	181	1.47
Isopoda	8	14	2	24	0.19
Formicoidae	525	725	624	1,874	15.18
Heteroptera	18	26	62	106	0.86
Hymenoptera	16	25	20	61	0.49
Chilopoda	15	21	24	60	0.48
Larvae	134	111	181	426	3.45
Lepidoptera	–	2	–	2	0.02
Lumbricida	4	1	8	13	0.10
Muridae	5	3	–	8	0.06
Opilionida	141	676	233	1,050	8.51
Orthoptera	66	45	106	217	1.78
Siphonaptera	–	4	–	4	0.03
Total	3,474	4 870	3,989	12,333	100.00

recorded for the *Hordeum vulgare* crop (3,474 ex). Ivask et al. (2008) is of the opinion that the level of biodiversity in agroecosystems depends on the vegetation cover, the sowing procedure, the intensity of management, i.e. on factors that significantly influenced biodiversity within the types of management we monitored. According to Černý et al. (2017), legumes differ from cereals in that they have little self-regulation ability, quality soil preparation plays an important role in growing *Pisum sativum*, depending on the kind and type of soil and the conditions in which peas are grown. According to Peterková et al. (2007) the presence of epigeic groups in the soil in different types of ecosystems is primarily related to their trophic preference, but also to their tolerance to given habitat conditions.

The amount of epigeic groups present can be evaluated positively. Some epigeic groups showed fluctuations in abundance, which can be explained by the topical agro climatic and trophic conditions of the habitat, intraspecific and interspecific relationships applied within the present populations, as are resulted by the calculated diversity values, which reached 1.9479 in the ecological management and 2.1229 in the integrated management. The values of faunal similarity according to Jaccard, when comparing individual types of the management systems, reached a value of 86.96%, and the value of identity of dominance according to Renkonnen had a value of 84.66%.

4 Conclusions

According to the aim of the study, attention was focused on the biodiversity of epigeic groups, in the years of 2019 and 2020, in the Nitra-Dolná Malanta location, within the ecological and integrated management systems. Ground traps method was used, which were exposed in identical crops within both agricultural management systems of *Hordeum vulgare*, *Pisum sativum*, *Vicia faba – Medicago sativa*. A total of 27,987 specimens of the epigeic group of animals were collected, 15,654 ex in the ecological system and 12,333 ex in the integrated management system. There were 23 Evertebrata orders, 1 order of Vertebrata, an undetermined group of Larvae was also present. The occurrence of epigeic groups in both management systems was almost the same, 22 epigeic groups occurred in ecological management and 21 in integrated management. Coleoptera, Collembola, Acarina, Formicoidae, Araneida recorded dominant occurrence. Subdominant representation was recorded in Opilionida. Occurrence lower than 1% was recorded in Auchenorrhyncha, Heteroptera, Chilopoda, Isopoda, Lumbricidae and others contributed to the biodiversity of the agroecosystem.

Among the selected crops, *Pisum sativum* and *Hordeum vulgare* presented the highest abundance, *Vicia faba* and *Medicago sativa* had the lowest occurrence in both management systems. The value of diversity was 1.9479 in the ecological system and 2.1229 in the integrated management system. The faunal similarity according to Jaccard, with the comparison of individual types of managements, reached a value of 86.96%. The identity value of dominance according to Renkonnen was 84.66%.

The ecological management system, compared to the integrated one, is predetermined for an abundant occurrence of epigeic groups, which together with suitable agro-climatic conditions of the habitat and suitable conditions for existence of soil fauna created by suitable crop cultivation, since ecological agricultural systems are characterized by greater floristic and faunistic diversity than integrated systems.

In conclusion, it can be stated that the abundance and representation of the present epigeic groups corresponds with the used collection method, the climatic conditions of the environment and the selected management system, with the cultivated crops.

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