Original Paper

The dispersion of Araneae in ecological and conventional farming conditions

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Agricultural land is a more important resource biodiversity and changes in their dispersion and structures reflected the quality of habitats. A suitable bioindicator pointing to such changes is the taxon Araneae. The aim of our research was to point out the dispersion of Araneae individuals in the ecological and conventional farming conditions and also the influence of pH, potassium, phosphorus, nitrogen on their abundance. During the years 2018 to 2021, we caught 2,862 individual Araneae in ecological farming (*Pisum sativum*, *Grass mixture*, *Triticum spelta* and *T. aestivum*) and conventional farming conditions (*Brassica napus*, *Hordeum vulgare* and *Zea mays*) using the pitfall trap method. The dispersion of Araneae individuals was the highest around crops in ecological farming. We confirmed a declining number of individuals with decreasing values of potassium, phosphorus and nitrogen in conventional and also ecological farming. However, the difference was within the limits of optima phosphorus, potassium and nitrogen, which were lower in ecological farming compared to integrated farming. On the basis our results, both types of farming can be evaluated as homeostatically, which affects the dispersion and abundance of Araneae. Providing them with topical and trophic conditions, which is important for the production of biomass and also affects the crop.

Keywords: Central Europe, agroecosystems, crops, diversity, management

1 Introduction

Ecological farming avoids and largely excludes the use of syntheticinputs (such asfertilizers, pesticides, hormones, feed additives etc) and rely upon crop rotations, crop residues, animal manures, off-farmorganic waste. Ecological farming is suitable an alternative to achieve ecological balance, biodiversity and also sustainability in production. This of farming is a modern system of tillage which are dealing with all over the world. Unlike to conventional of farming, has a positive effect on the biodiversity of animals, plants, and their protection (Hazarika et al., 2013; Porhajašová et al., 2015). In ecological farming is not used pesticides, synthetic fertilizers, or growth regulators. Ecological farming management use green manure, crop residues, crop rotation, animal manure, and also pest control to maintain soil productivity. The soil in ecological farming, has higher microbial activity and also organic matter content. The risk of contamining water resources with pesticides is low. Benefits of ecological farming are follow: reduce production cost by over 25%, eliminating the use of synthetic fertilizers, artificial flavors, preservatives andpesticides, increasing crop yield up to five-foldwithin 5 years, environment friendly, Increase long term fertility of soil, supports the local farmers and economy (Wollni & Andersson, 2014; Faly et al., 2017). The ecological stability of the agricultural landscape increases based on higher species richness of animals and plants (Porhajašová et al., 2014).

Conventional farming is a traditional, industrial agriculture, refers to farming systems which include the use of synthetic chemical fertilizers, pesticides, herbicides, genetically modified organisms, intensive tillage and irrigation, is typically highly resource-demanding and energy-intensive, but also highly productive. This System is an interdependent and interlockingproduction systems based on few crops, such a way that maximize the utilization of nutrients of each system. Is a strategy for harmonizing joint management of land, water, vegetation, livestock and human resources. Conventional

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farming uses chemical to against weeds and pests, which ensures higger productivity, and that is why farmers use them. However, the toxic elements located in pesticides and fertilizers accumulate in the crops, and consuming products lead to diseases in the consumers. In the soil create a residual effect and thereby burden the environment. Revolutionized of techniques machines in the agricultural sector replaced human resources in work, which led to the problem of unemployment. However, management practices used in organic farming e.g., organic fertilizers and more diverse crop rotations are utilized more and more in conventional farming approaching the idea of an integrated farming system (Simão et al., 2015; Briones & Schmidt, 2017).

Soil is a more important part of the environment, which undergoes complex processes in organic and inorganic phases. Also, biochemical reactions are dependent on soil enzymes (González et al., 2021). Epigeic diversity is a more important indicator of soil quality. Araneae has (have?) an important role in the decomposition of biomass, in the cycle of carbon, phosphorus, nitrogen, sulfur in the environment, in the degradation of toxic substances, and their influences on soil fertility (Zazharskyi et al., 2019). Araneae contribute to the reduction of pests damaging crops and therefore belong to beneficial insects of fields. They contribute to productivity, stability agroecosystems, and better soil fertility (Wall et al., 2015). Decrease in Araneae individuals in agroecosystems is caused by agricultural production, cultivation of monocultures in large areas, use of pesticides, and insecticides.

We expect that our results will contribute new information on the dispersion of individual Araneae in ecological and conventional farming conditions.

2 Material and methods

The research was done in the years 2018 to 2021, and the Araneae were harvested in seven crops. Five crops with ecological (*Triticum spelta*, *Triticum aestivum*, *Pisum sativum*, *Grass mixture*) and three crops with conventional farming (*Hordeum vulgare*, *Brassica napus*, *Zea mays*) methods. For each field we used five pitfall traps, these traps were placed in a line at distances of 10 m between pitfall traps. The material fixation was used 4% formaldehyde solution. Pitfall traps were collected every two weeks, and taxon of Araneae was determined according to the work of Schierwater & DeSalle (2021).

The study areas were locatedin the geomorphological unit Podunajská pahorkatina – Danubian upland (the south-western part of Slovakia) inthe cadastral territory of Nitra (48° 17′ 04.4″ N 18° 06′ 58.8″ E) (Figure 1). The altitude of the study area was 130 m above sea level, and the type of soil is brown soil. The monitored area has a warm, arid climate with mild winters. The mean temperature ranges during each month were as follows: January -5–5 °C, February -3–6 °C, March 0–12 °C, April 10–20 °C, May 15–22 °C, June 18–27 °C, July 22–29 °C, August 20–29 °C, September 15–23 °C, October 8–15 °C, November -3–7 °C, December -5–5 °C. The average precipitation for each month was as follows: January 30 mm, February 26 mm, March 35 mm, April 12 mm, May 65 mm, June 77 mm, July 41 mm, August 57 mm, September 64 mm, October 54 mm, November 40 mm and December 55 mm.

Tillage was based on annual tillage plowing, incorporating crop residues and weeds into the soil, and pre-sowing preparation with sowing were combined. In conventional farming, the insecticide FORCE intended for soil application to control soil pests was used. We measured pH, potassium, phosphorus, nitrogen using meters types (meter types?) Dexxer PH-03 and Rapitest 3 1835.

2.1 Data analyses

Detrended correspondence analysis (DCA) was employed to determine the dispersion of a number of individuals Araneae between the crops in the Canoco5 program (Ter Braak & Šmilauer, 2012).

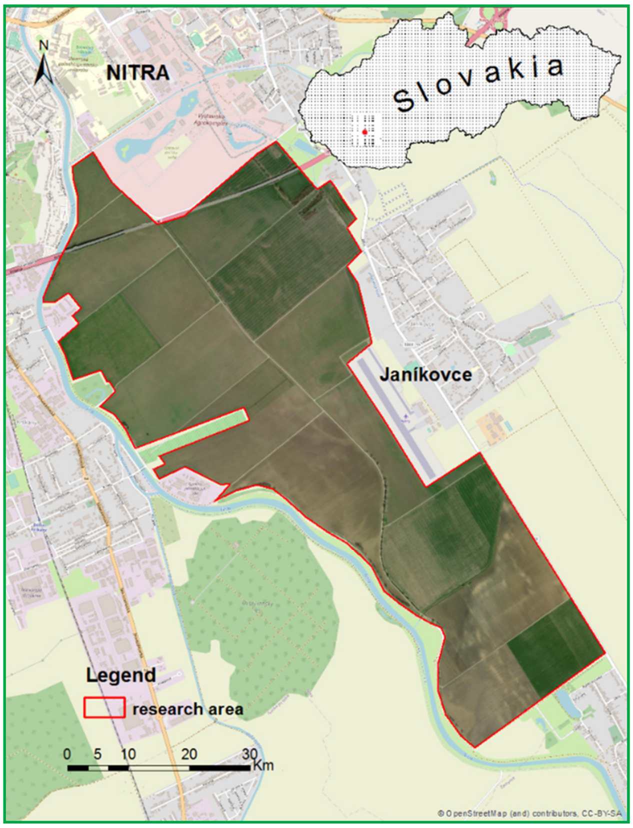

Figure 1 Map of the study area

Analysis in the statistical program R. 3.6.3 (2020) was focused on linear regression, expressing the relationship between the number of Araneae and the values of potassium, phosphorus, nitrogen, and pH.

3 Results and discussion

Over the research period, we found a total of 2,862 individuals Araneae, the highest number of individuals was recorded in the *Grass mixture* (59.36%), *Hordeum vulgare* crops (16.88%), and *Pisum sativum* (11.43%). The lowest number of individuals was observed in the *Zea mays* (3.7%), *Triticum spelta* (3.18%), *Brassica napus* (3.32%), and *Triticum aestivum* (2.13%) crops.

Using Detrended correspondence analysis (DCA, SD = 4.7 on the second ordination axis) of Araneae, we observed dispersion of Araneae in crops with ecological (*Pisum sativum*, *Grass mixture*, *Triticum spelta*, and *Triticum aestivum*) and conventional farming (*Brassica napus*, *Hordeum vulgare*, and *Zea mays*). The graph shows that the type of dispersion of individual Araneae is clustered. Furthermore, the predominance of individuals Araneae is ordered around crops in ecological farming (Figure 2).

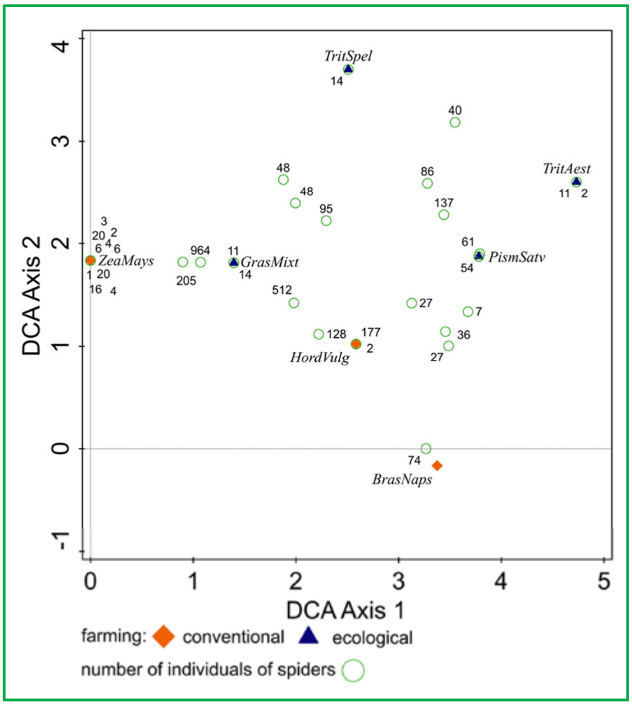

Figure 2 DCA analysis dispersion of individuals of Araneae in crops

The composition of fields influence management, use and scale of land, which is a source disease, pests and weeds. Diversity plants is an another factor that influence the individuals of Araneae (Haddaway et al., 2016). They ensure with their activity the decomposition of arthropods residues and improved quality structure soil (Diehl et al., 2013). Pérez-Bote & Romero (2012) also confirmed a decline in individuals of Araneae with increasing soil use. Araneae use in biological control can improve ecosystem conservation and ecological farming (Dobrovodská et al., 2019; Purgat et al., 2020).

In the regression model, we found the influences between environmental variables (potassium (mg/kg), phosphorus (mg/kg), nitrogen (mg/kg) and pH), and the number of individuals Araneae in ecological farming conditions (*Pisum sativum*, *Grass mixture*, *Triticum spelta*, *Triticum aestivum*). The high correlation coefficient value was for the number of individuals and pH (r = 0.716) (Figure 3A). A medium-strong (medium-strong) negative relationship, we recorded at phosphorus (r = -0.648) (Figure 3B), nitrogen (r = -0.625) (Figure 3C) and potassium (r = -0.639) (Figure 3D) which indicated negative impact of environmental variables (potassium, phosphorus, nitrogen) on the number of individuals in ecological farming conditions. The regression models is statistically significant in all cases pH (p = 0.0485), potassium (p = 0.0354), phosphorus (p = 0.0258) and nitrogen (p = 0.0435). Increasing values of potassium, phosphorus, and nitrogen reduce the number of individuals Araneae. The ideal values for Araneae in integrated farming conditions were 5–40 mg/kg nitrogen, 5–40 mg/kg potassium, 0.5–3 mg/kg phosphorus and pH 7.

Araneae belong to important groups of arthropods in terms of high species richness, number of individuals, functional roles in ecosystems, and biomass (Jocqué et al., 2013; Nentwig, 2013; Mammola et al., 2017). Araneae living in fields have a bigger tolerance to anthropogenic intervention than the Araneae living in natural biotopes (habitats?). They have a high local abundance on fields caused the influence of agriculture (Alberti et al., 2017; Magura et al., 2020). Their influence the natural balance in ecosystems and also the substance cycle of nitrogen, carbon, phosphorus, or sulfur. The eudominance of Araneae is a general characteristic of epigeic groups, which their activities improve soil quality, structure and aerated (Boháč & Jahnová, 2015).

In conventional farming (*Brassica napus*, *Hordeum vulgare*, *Zea mays*), we also found the influence of environmental variables (potassium (mg/kg), phosphorus (mg/kg), nitrogen (mg/kg), and pH) on the number of individuals Araneae. The medium-strong (medium-strong) relationship was for the number of individuals and pH (r = 0.622) (Figure 4A). The medium-strong (medium-strong) negative relationship, we recorded at phosphorus (r = -0.431) (Figure 4B), nitrogen (r = -0.591) (Figure 4C) and potassium (r = -0.617) (Figure 4D) which indicated negative impact of environmental variables

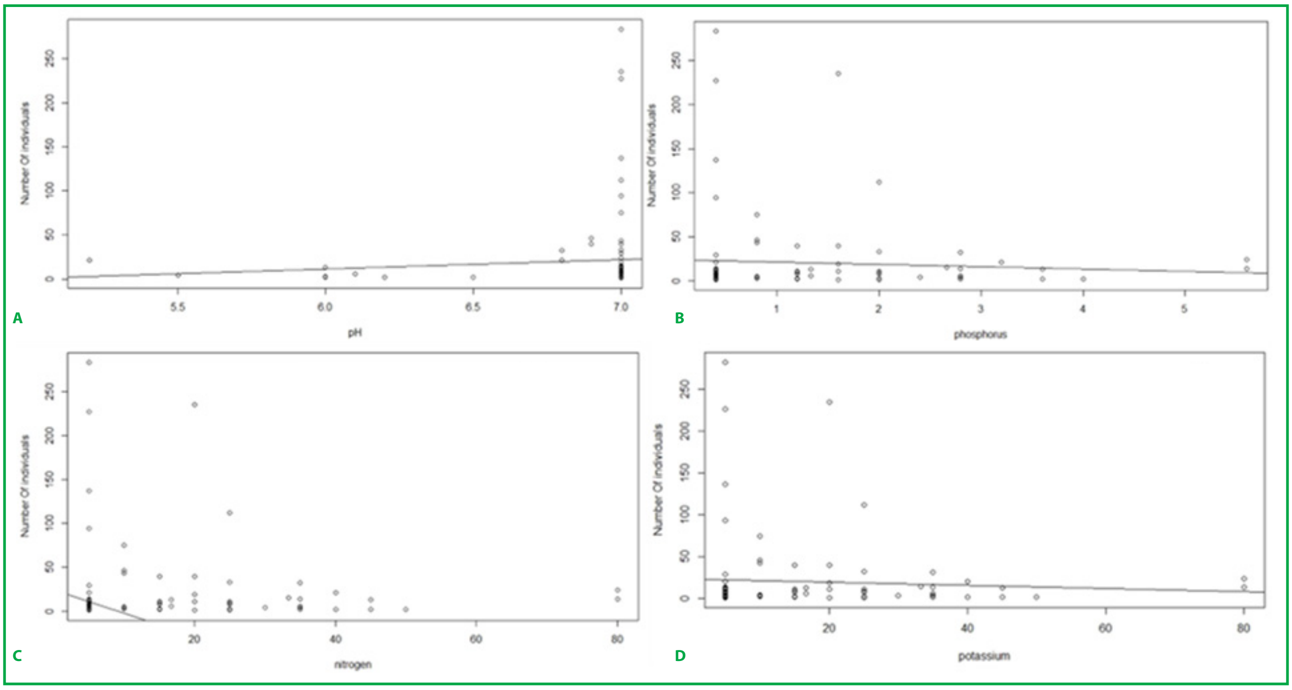

Figure 3 Linear regression of pH (A), phosphorus (B), nitrogen (C), potassium (D) and of individuals Araneae in ecological farming conditions

(potassium, phosphorus, nitrogen) on the number of individuals in integrated farming conditions. The regression models is statistically significant in all cases pH (p = 0.0274), potassium (p = 0.0268), phosphorus (p = 0.0284), and nitrogen (p = 0.0182). Increasing values of potassium, phosphorus and nitrogen reduce the number of individuals Araneae. The ideal values for Araneae in integrated farming conditions were 5–50 mg/kg nitrogen, 5–50 mg/kg potassium, 0.5–4 mg/kg phosphorus and pH 7.

Soil disturbance of caused by applying manure cause a decline in individuals Araneae. Preserving spider abundance is necessary because they play an important ecological role in providing ecosystem services to control

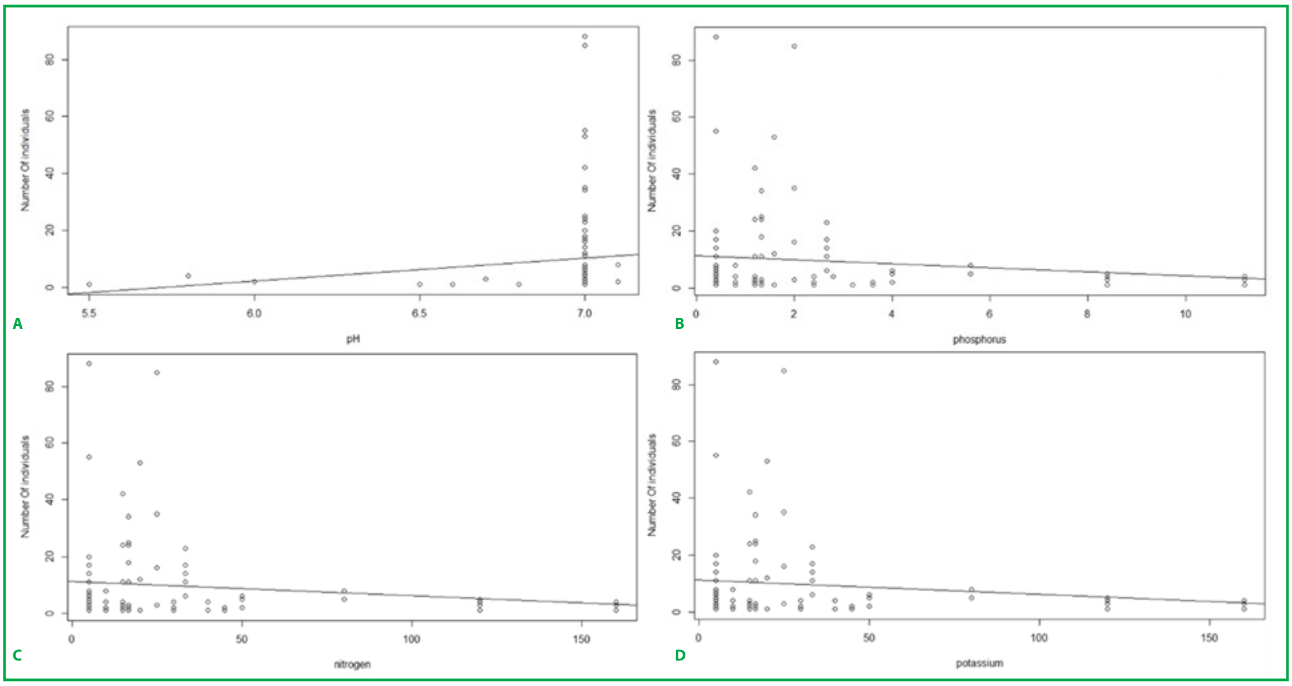

Figure 4 Linear regression of pH (A), phosphorus (B), nitrogen (C), potassium (D) and of individuals Araneae in integration farming conditions

pests in fields (Nyffeler & Birkhofer, 2017; Michalko et al., 2019, Schuster et al., 2019). The order Araneae reacts negatively in agroecosystems to influence of pesticides, insecticides, artificial fertilizers, pH, and soil moisture. Another factor is vegetation structure, which affects the presence of prey for spiders. This structure depends on anthropogenic intervention, which is stronger (more robust?) in fields ecosystems (Tiemann et al., 2015).

4 Conclusions

The results of our research provided new knowledge regarding the dispersion of Araneae in crops in ecological (*Pisum sativum*, *Grass mixture*, *Triticum spelta*, *Triticum aestivum*) and conventional farming (*Brassica napus*, *Hordeum vulgare*, *Zea mays*) conditions. In the DCA analysis, we pointed out the predominance dispersion of individuals Araneae around ecological farming. In ecological and integration farming, we found a positive correlation between the number of Araneae and pH. Negative correlation we confirmed between the number of Araneae and phosphorus (mg/kg), potassium (mg/kg), and nitrogen (mg/kg) in both types of farming. However, the difference was within the limits of optima phosphorus, potassium and nitrogen, which were lower in ecological farming. We can conclude that ecological farming with the higher number of spider individuals is important for increasing biomass affecting crop yields, nutrient cycling, pest control, and maintenance of soil structure.

Acknowledgments

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