Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(2), 8-12, doi: 10.15421/2021_69

ORIGINAL ARTICLE *UDC 632.9: 632.76: 631.58*

Effect of various agriculture systems on pest entomofauna diversity

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Received: 04.02.2021. Accepted: 04.03.2021.

Aim. To investigate the ecological and biological aspects of the formation of entomophauna in agrocenoses of sugar beets, winter wheat, peas, and soybeans according to organic, industrial, and No-till systems. **Results.** We established that farming systems significantly affect the formation of harmful and useful entomophauna in agrocenoses. In particular, under the organic system, the density of the carabidae population was 1.7–2.7 times higher than in industrial and 3.5 times higher than the No-till system. The number of Coccinellidae larvae and imago under the organic farming system exceeded these figures by 8.3 times compared to industrial. Accordingly, the presence in agrocenoses of useful entomophauna affected the number of certain phytophagous. In particular, the population density of the common beet weevil (*Bothynoderes punctiventris* Germ.) and beet leaf weevil (*Tanymecus palliatus* F.) in sugar beet crops under the organic system was 2.2–4.2 times lower compared to the industrial one. This also applies to pests such as bug, sunn pest (*Eurygaster integriceps* Put.), and wheat grain beetle (*Anisoplia austriaca* Herbst.) in winter wheat crops, the number of which under the organic system was 1.2–2.5 times less than in industrial. **Conclusions.** Preservation of useful entomofauna in agrocenoses in the absence of the use of means of protection of chemization of the outfit in compliance with the alternation of crops in crop rotation, high-quality tillage, and other agrotechnical measures contributes to the restoration of natural self-regulation of insect groups, which is the basis for effective control of the number of phytophagous in crops.

Keywords: agrocenoses, entomophagous, means of chemization, farming systems, test objects, phytophagic, population density.

Introduction

Farming systems play an essential role in controlling the number of harmful and useful entomophauna. The organic (biological) system excludes chemization tools, which significantly affects the preservation of beneficial insects and the formation in agrocenoses of the principle of self-regulation of their groups. The results of our research coincide with the conclusions of some authors that the reduction or exclusion of the use of chemization tools in the technologies of growing crops and the use to control the number of phytophagous and reduce plant damage by diseases, if necessary, of drugs of biological origin contributes to the accumulation of beneficial entomophauna. In particular, this approach to solving the problem of plant protection against pests and diseases is discussed in the works of Korniychuk M.S. (Korniychuk, 2013, 2017), Borzykh O., Tkalenko A. (Borzykh, Tkalenko, 2018), which is consistent with our conclusions. Creating conditions in the fields to preserve beneficial insects by eliminating pollution by their means of chemization will contribute to the manifestation of predation, parasitism, and competition between living organisms for survival.

There are different agriculture systems (Kaminskyj et. al., 2015; Gadzalo et. al., 2016; Gutorov , 2013; Kosolap et. al. , 2011) in the agriculture of Ukraine. In particular, along with the traditional industrial system, which provides for the use of mineral fertilizers, growth regulators, and plant protection products in the cultivation of crops, it has become widespread the organic or biological system of agriculture in recent years. The last is based on the natural method of obtaining agricultural products without using chemization products in technologies, but only if biological preparations are needed to control the number of phytophagous and plant diseases (Borzyh et. al., 2018; Tkalenko, et. al., 2018; Antonec et. al., 2014).

Besides, the introduction of energy-saving technologies with appropriate tillage methods aimed at preserving and reproducing its fertility is becoming increasingly common. Simultaneously, the emphasis is placed on the minimization of tillage operations that contribute to the implementation of biological possibilities of biocenoses self-regulation. Such soil cultivation systems compared to traditional methods contribute to better accumulation and preservation of moisture in the upper layer of the soil and optimize the nutritional regime (Kosolap et. al., 2011; Maliyenko et. al., 2013; Pysarenko et. al., 2002, 2016). Simultaneously, these systems significantly affect the formation of harmful and useful entomophauna in agrocenoses, which allows the introduction of methods for managing population dynamics. The latter is significant since the principle of self-regulation of insect groups in agrocenoses is at the heart of this process; that is, due to the absence of optimization of the use of chemical measures to protect plants, beneficial insects are preserved – entomophagous that feed on phytophagous, or parasitize them and thus maintain their numbers at a certain level (Stankevych et. al., 2016; Sabluk et. al., 2018; Vorozhko et. al., 2017).

Studies of many scientists have found that the means of chemization used in technologies in the cultivation of crops according to the traditional (industrial) system of agriculture reduces the population of beneficial insects in agrocenoses or eradicates them. In turn, this leads to the rupture of natural connections between living organisms in agrocenoses, conditions for mass accumulation of certain species of phytophagous are created, and there is an urgent need to control their numbers mainly using the same means of chemization, and this is repeated from year to year (Pysarenko et. al., 2002; Stankevych et. al., 2016; Vorozhko et. al., 2017).

Under the organic system of agriculture, when pesticides and agrochemicals are not used, there is an accumulation of beneficial entomophauna, natural connections between living organisms in agrocenoses are restored, and self-regulation of insect groups is carried out, that is, the number of all insect species is maintained at a certain level, without destroying each other. Due to this

equilibrium, outbreaks of mass accumulation of certain species and the density of the phytophagous population, for the most part, do not exceed the economic thresholds of their harmfulness (Kornijchuk et. al., 2017; Pysarenko et. al., 2002; Stankevych et. al., 2016).
The purpose of the article was to investigate the ecological aspects of the formation of entomophauna complexes in agrocenoses of sugar beets, winter wheat, peas, and soybeans according to organic, industrial, and No-till systems.

Methodology

The research was carried out in the Department of Agriculture and Herbology of the National University of Life and Environmental Management of Ukraine (Pshenychne village, Vasylkiv district, Kyiv region) during 2016-2018. according to generally accepted entomology methods (Roik et. al., 2014) and methods of researching beet production (Omeluta et. al., 1986). In particular, the density of the population of carabidae was established with the help of Barber traps, into which migrating terrestrial insects fell. In each version, 10 Barber traps were installed at the rate of 1 trap per area of 50 m^2. Every ten days, insects were chosen from traps and determined their number and species.
The number of common beet weevil (*Bothynoderes punctiventris* Germ.) and beet leaf weevil (*Tanymecus palliatus* F.) was determined by square method; Coccineliidae larvae and imago, imago of sunn pest and wheat grain beetle, were counted on 100 plants. The industrial system of agriculture provides for the use of chemization products in technologies. In contrast, the organic farming system is based on organic fertilizers, by-products of crop production, biological means of plant protection, and plant growth regulators of natural origin. Control of the number of phytophagous, disease damage to plants, and protection of crops from weeds from pests, diseases, weeds are carried out exclusively by agrotechnical and biological methods. No-till is a zero-cultivation system for soil cultivation, in which control in the fields of weeds, diseases, and pests is carried out in traditional ways, that is, with the help of pesticides of various origins without the use of mechanical means, all by-products remain on the soil surface.
As for meteorological conditions during the years of the study, according to the Bila Tserkva meteorological station, they differed significantly from the average perennial (Figs. 1 and 2).

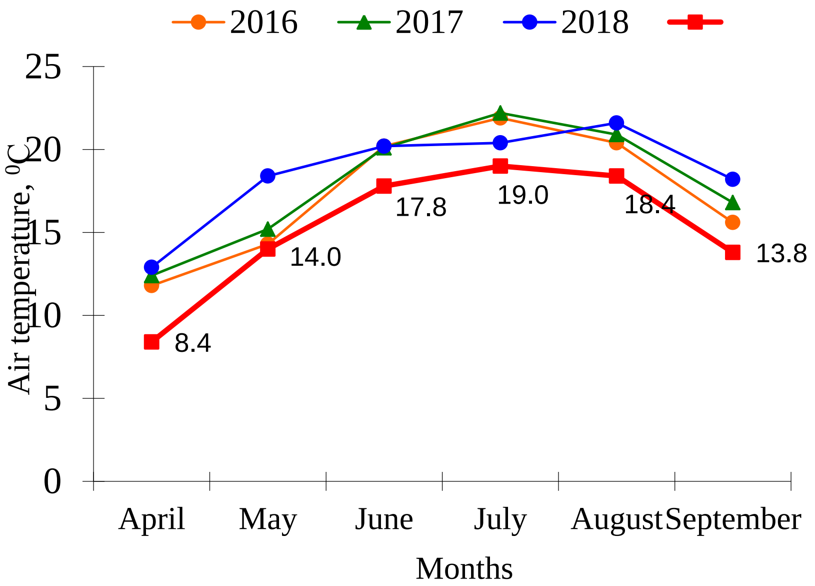

Fig. 1. Indicators of air temperature in the area of research (according to the Bila Tserkva Weather Station, 2016-2018.

In particular, the air temperature during the growing season of plants (April-September) in all years was 0.5-3.4 degrees higher than the average perennial. The amount of precipitation in April-May of 2016-2017 was significantly higher, and in 2018 it was much less than the annual average. In the summer months (June-August), the amount of precipitation was significantly lower (except for 2018 in June) compared to the average long-term.

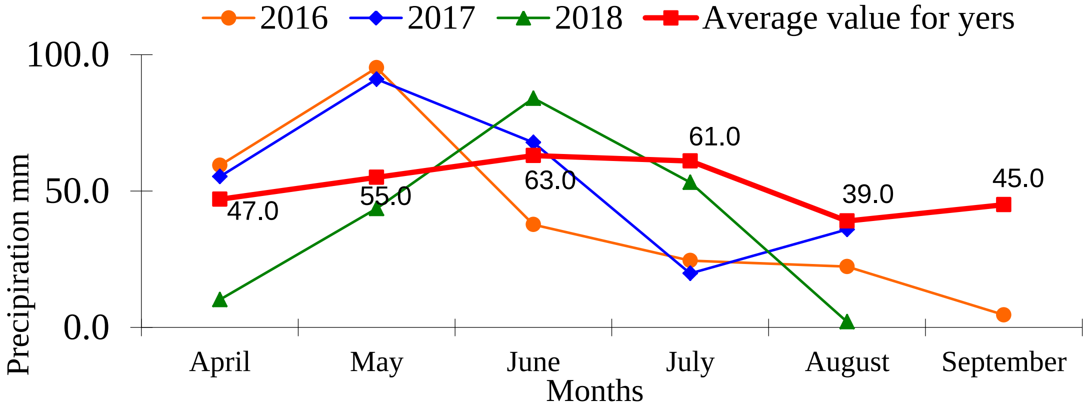

Fig. 2. Indicators of the amount of precipitation in the area of research (according to the Bila Tserkva Weather Station, 2016-2018).

Typical soils in chernozem experiments are small-humus coarse - medium-aggregated, humus content - 3.86%, soil pH close to neutral. Soil density – 1.16–1.25 g/cm^3. The content of productive moisture in the meter layer of soil is 140-180 mm, the water regime of the soil belongs to the semi-oil type. The moisture factor is not limited.

Results

We established that farming systems significantly affect relationships between insect groups in agrocenoses of various crops. We also registered that under the organic agriculture system, the population density of insects was significantly higher (1.7-2.8 times) than in intensive (Fig. 3).

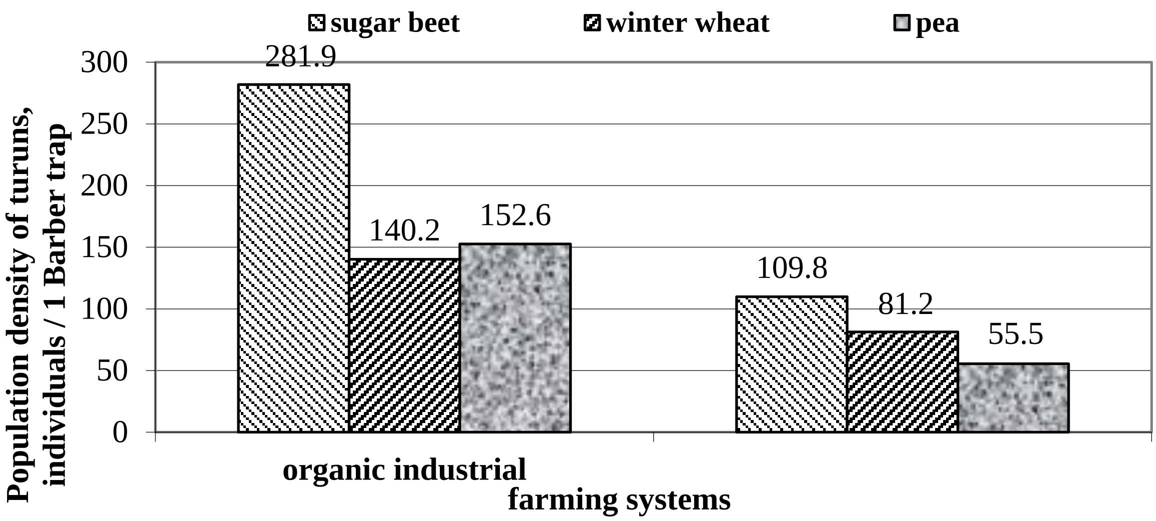

Fig. 3. Population density of carabidae in crops (Pshenychne village, Kyiv region, 2016-2018.

In particular, during the growing season, sugar beet variants with organic farming were caught on average by one trap of 281.9 individuals of carabidae, while under the industrial system, these indicators were much smaller and amounted to 109.8 ind./trap. Slightly smaller was the difference in the number of these insects in winter wheat. On average, the number of sunn pest individuals per trap under the industrial system was 81.2 vs. 140.2 individuals in the organic. In pea crops, these figures were 152.6 against 55.5 individuals on average per trap. Consequently, the population density of carabidae largely depends on the farming system, as evidenced by research results. The presence of entomophagous in agricultural products, in turn, affects the number of pests. According to the accounting of the main phytophages in the crops of sugar beets, winter wheat, and peas during their growing season, the density of the population of harmful insects in agrocenoses under the organic farming system was significantly lower compared to industrial (Table 1).

Table 1. Population density of major pests under various farming systems (Pshenychne village, Vasylkiv district, Kyiv region, 2016-2018).

Pest	Farming system	Unit of measure	Population density	Many times more	Culture
Bothynoderes punctiventris Germ.	Organic	ind./m^2	0.66	-	Sugar beet
	Industrial		1.44	2.2	
Tanymecus palliates F.	Organic	-«-	0.39	-	-«-
	Industrial		1.63	4.2	
Eurygaster integriceps Put.	Organic	-«-	5.25	-	Winter wheat
	Industrial		13.25	2.5	
Anisoplia austriaca Herbst.	Organic	-«-	5.25	-	-«-
	Industrial		6.25	1.2	
Oulema melanopus L.	Organic	-«-	2.75	-	-«-
	Industrial		5.75	2.1	
Bruchus pisorum L.	Organic	ind. per 100 plants	38.0	-	Peas
	Industrial		30.0	-	
Laspeyresia nigricana F. - larvae	Organic		303.0	-	
- imago	Industrial	ind./trap	327.0	1.1	-«-
	Organic	ind. per 100 plants	39.0	-	
	Industrial		32.0	-	

In particular, the number of common beet weevil and beet leaf weevil in sugar beet crops under the organic agriculture system was 2.2-4.2 times lower compared to industrial. This also applies to such winter wheat pests as sunn pests and wheat grain beetle; the organic system's population density was 1.2-2.5 times lower than under the industrial system. Consequently, the population density of the main species of phytophages in the crops of sugar, winter wheat, and peas depends heavily on the presence of entomophagous in agrocenoses, such as various carabidae, which play an essential role in regulating the number of phytophages. This also determines the presence of Coccineliidae larvae and imago in agrocenoses. According to our research results, the number of these beneficial insects in sugar beet crops largely depends on farming systems (Fig. 4).

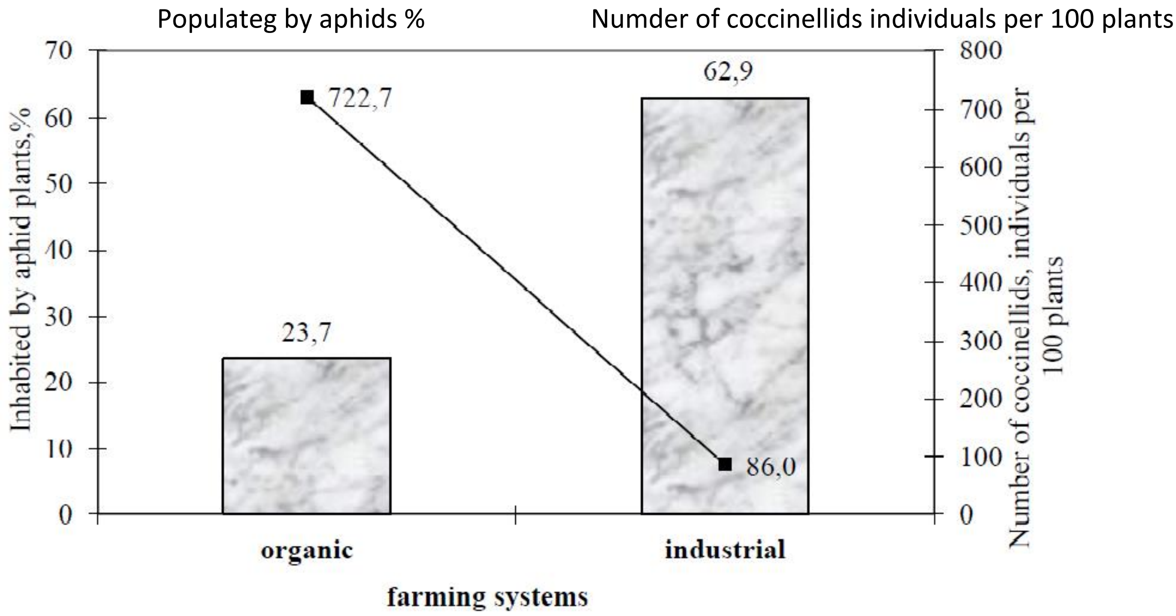

Fig. 4. The infestation of beet plants with beet *Aphis fabae* Scop. on Coccineliidae number (Pshenychne village, Kyiv region, 2016-2018).

In particular, 722.7 exotic coccinellids were detected under the organic farming system during the crop's growing season. On 100 plants, under the industrial system, these insects' population density was respectively 86.0 ind./100 plants, which is a total of 11.9 percent of their organic population, or was 8.3 times smaller.

Accordingly, this population density of entomophagous affected the settlement of plants of this crop with aphids, which under the organic farming system was 23.7%, and in industrial it was almost three times larger and equal to 62.9%.

We registered that in 2016 the difference between them in organic and industrial farming systems was the largest (by 10.2 times) and in 2018 the smallest (by 5.3 times), which is due to weather conditions that developed during the growing season (Table 2). In particular. the rainfall for May-September in 2016 and 2018 was 358.0 and 224.0 mm.

Table 2. The infestation of beet plants with beet *Aphis fabae* Scop. under various farming systems (Pshenychne village, Vasylkiv district, Kyiv region, June–September of 2016-2018.

	Plant infested with aphids			The ratio of the number of apes by the industrial system to organic	
	%	Ball	Factor	%	times more than
Organic	23.7	1.0	0.24	12.8	-
Industrial	62.9	3.0	1.88	100	7.8
Organic	19.8	1.0	0.20	9.8	-
Industrial	73.2	2.8	2.04	100	10.2
Organic	27.7	1.0	0.27	12.5	-
Industrial	63.4	3.4	2.16	100	8.0
Organic	27.6	1.0	0.27	19.5	-
Industrial	52.1	2.8	1.44	100	5.3

Conclusions

The lack of use of chemization tools in technologies in the cultivation of crops under the organic farming system contributes to the accumulation of useful entomophauna in agrocenoses, a significantly smaller number of phytophagous compared to the industrial farming system.

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Citation:

Sabluk, W.T., Sinchenko, V.M., Grishchenko, O.M., Gumentik, M.Ya., Fedorenko, A.V. (2021). Ecological Aspects of Formation of Entomofauna Complexes in Agrocenoses under Different Systems of Agriculture. *Ukrainian Journal of Ecology, 11* (2), 8-12.