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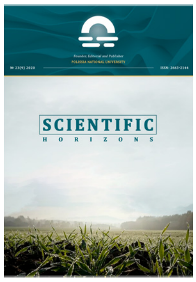

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Phytocoenotic assessment of herbaceous plant communities in the organic sweet cherry orchard

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Abstract. Biodiversity loss is one on global environmental issues facing humanity. Intensive use of natural resources has led to degradation of landscapes and reduction of the species diversity of plant communities. Therefore, finding natural solutions to overcome these challenges is an urgent issue. The purpose of the study was to investigate the dynamics of floral composition and coenotic structure of herbaceous plant communities in an organic cherry orchard for the sustainable functioning of the

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agricultural landscape. The dynamics of the coenotic composition of natural grasses of vegetation cover in the organic cherry orchard was studied during 2013-2020 in the arid conditions of the Southern Steppe of Ukraine on low-humus sandy loam soils. Morphological, ecological, and geographical methods were used to investigate the species diversity of flora in an organic garden. The composition of herbaceous plant communities was estimated using conbentional geobotanic description methods. The results of the study of the species composition and coenotic structure of plant communities of grass cover in an organic sweet cherry orchard are presented. Grassing of the garden with natural grasses has led to the enrichment of agricultural landscapes with useful species that are important components of sustainable agricultural systems and can perform ecological services. Colonisation of the grass cover by invasive and quarantine species was not observed due to natural processes of demutation succession and the use of moderate four-fold mowing of plants during the growing season (to a height of 15-20 cm). As part of herbal plant communities in the 8th year of research, all species were useful, had medicinal properties, and served as a food base. The natural grasses in an organic sweet cherry orchard are a resource of biomass and biodiversity. Phytocoenotic analysis of the grass cover in the organic cherry orchard will allow substantiating and proposing principles for predicting the development of plant communities to optimise their structure, improve quality, and maintain biodiversity

Keywords: species composition; biodiversity; environmental services; grass cover; coenomorphs; secondary succession; natural restoration of agroecosystems

INTRODUCTION

The increased anthropogenic impact on natural ecosystems has led to a serious violation of the state of the environment, including a reduction in the area of territories occupied by ecosystems and being the habitat of biological species. A significant part of landscapes is rapidly degraded due to the intensive use of natural resources and economic activity. The scale of anthropogenic pollution is extremely large, so natural compensatory processes are not able to offset their harmful effect on the state and species diversity of plant communities and ecosystems in general. The international community has repeatedly stressed the need to take decisions to prevent the negative impact of human economic activity on biodiversity, which corresponds to the present.

Current trends in horticulture provide for the greening of this branch of agriculture. Greening horticulture involves the introduction of organic gardening. In order to protect the soil in organic gardens, "live mulch" is increasingly used – the soil should be covered with live plants, most often sown with cover crops (Mia *et al.*, 2021). However, the cultivation of cover crops requires additional financial investments, which may not be justified due to the low competitive ability of cultivated species against the local weed flora (Licznar-Małańczuk, 2020).

However, the use of the local weed flora itself as a live mulch can be useful for many reasons: firstly, to preserve the local authentic flora; secondly, natural grasses, due to their adaptability to local conditions, are able to form a dense cover for the soil (Oldfield *et al.*, 2019). This, in turn, helps to protect the soil surface from overheating in summer and freezing in winter, slow down the wind speed, and reduce the impact force of raindrops (protect the soil from deflation and dispersion). Grass not only slows down water erosion of the soil, but is also a nesting site for beneficial insects (Carvell *et al.*, 2022). The grass rhizosphere is a habitat for numerous soil biota (including mycorrhizal fungi. The results of research have established that mycorrhizal fungi can enhance the adaptive properties of plants to stressors. The functioning of mycorrhizal symbioses in organic gardens improves the growth and development of plants, increases their yield, and ensures the sustainable development of agriculture and biodiversity conservation (Gerasko *et al.*, 2023).

Flowering natural grasses can attract pollinating insects to the garden (Antoine & Forrest, 2021; Mateos-Fierro *et al.*, 2021). The loss of habitat, in particular flower resources, is one of the main reasons for the decrease in the number of pollinating insects and their diversity in agricultural landscapes, and, as a result, makes entomophilic pollination of plants impossible. Pollinators can affect the stability, diversity, and functioning of plant communities. In agroecosystems, pollinators are able to provide ecosystem services, affect crop yields and product quality, which ensures sustainable development of agriculture and solving food security problems (Kowalska *et al.*, 2023). Since sweet cherries are recognised as a geographical brand in the south of Ukraine, the blooming grass cover in the organic garden of this crop can serve as a tourist magnet of the region. This will create new opportunities for the country's economic development, which is especially important for its recovery in the post-war period (Trusova *et al.*, 2020).

Despite all these advantages, using weeds as live mulch can be harmful due to the dominance of invasive, quarantine species. To install live mulch made from natural grasses, it is necessary to stop the black fallow regime. It is known that the cessation of tillage in abandoned areas (fallows) leads to secondary succession with a gradual restoration of authentic flora (Borovyk, 2020). The rate of achievement of the quasi-climatic state of the phytocoenosis depends on many factors: soil and climatic conditions, the location of the site, anthropogenic activities (mowing, grazing), the seed bank of authentic species (Szirmai *et al.*, 2022). However, now there is practically no information about the course of succession processes of natural grasses as live mulch in the conditions of the Southern Steppe of Ukraine. In this regard, there is a need for further scientific research and comprehensive study to develop a strategy for harmonious sustainable agricultural development in the concept of biodiversity conservation.

The purpose of this study was to determine the dynamics of the coenotic composition of natural herbs in the organic cherry orchard during the eight years of live mulch existence in the Southern Steppe of Ukraine. From a practical standpoint, it was necessary to find out whether grassing the garden with natural herbs would lead to the enrichment of the phytocoenosis with useful species (capable of providing valuable environmental services), or, conversely, to colonisation by invasive, quarantine species, and whether it was possible to prevent the spread of invasive and quarantine species due to moderate mowing (to a height of 15-20 cm, 4 times during the growing season).

MATERIALS AND METHODS

The study was conducted during 2013-2020 in the Research Garden owned by the Tavria State Agrotechnological University (Zelene village, Melitopol district, Zaporizhzhia Oblast: 46°46'N, 35°17'E).

Characteristics of natural vegetation of the research area. Due to extensive ploughing, the natural authentic herbaceous and fescue vegetation remained on the slopes of the gullies, in some areas of watersheds, and near the forest edges. The most characteristic representatives of mixed grasses were the following: *Adonis vernalis L., Paeonia tenuifolia L., Filipendula vulgaris Moench, Fragaria viridis Duschesne, Plantago lanceolata L., Dianthus capitatus Balb., Salvia nutans L., Draba verna, Limonium sareptanum (A.Becker) Gams, Centaurea adpressa Lede,* etc. Of the cereals, the most common were the following: *Stipa capillata L., Stipa pennata L., Bromus erectus, Bromopsis inermis (Leyss.) Holub, Festuca valesiaca, Elytrigia repens (L.) Nevski, Poa angustifolia L.* Of the legumes, the most common were the following: *Trifolium alpestre, Medicago minima (L.) Bartalini and Vicia angustifolia.*

Soil characteristics. According to the soil and ecological zoning of land resources of Ukraine, the territory of the research site belonged to the dry steppe zone, dry steppe subzone, winter-moderate-warm facies (frost period lasts 75-90 days, cold period precipitation is absorbed by 72%). Hydrothermal conditions of soil development were characterised by the arid first part of the growing season (hydrothermal index $_{V-VI}$ = 0.64 - 0.73) and very dry conditions of the second part (hydrothermal index $_{VII-IX}$ = 0.40 - 0.49) with moderate humidity during cold time (140-160 mm). The soil of the experimental site was chestnut saline, very low humus accumulation, heavy sandy loam, xeromorphic, superficially saline, lithological series – ancient alluvial. Ground water was below 3 m. The reaction of the soil solution was slightly alkaline (pH = 7.1 - 7.4). The humus content in the upper horizon of the soil of light particle size distribution was only 0.6%. No mineral nitrogen was detected, content of P_2O_5 was 5.4; K_2O – 6.5 mg/kg of soil. There was no salinity with water-soluble salts – the total content of water-soluble salts in the water extract did not exceed 0.015-0.024%. No easily soluble neutral salts (magnesium, sodium chloride, sulphates, calcium) were found in the soil in amounts that cause toxic effects on tree growth and development. A high specific gravity of sodium up to 3.5% of the total absorbed bases indicates salinity of the soil. Despite the poor soil composition, sweet cherries have been successfully grown in this region since the 19th century and have excellent fruit quality on such sandy loam soils. The light granulometric composition of the soil, due to its high thermal conductivity, contributes to the early harvesting of products compared to plantations on heavy soils.

Weather conditions. Analysing weather conditions over the years of research (Tables 1 and 2), a trend towards climate warming can be stated, since the average annual air temperature was 0.8-1.6°C higher than the normal annual average rate.

Table 1*. Average air temperature in the research area, °C (according to the nearest weather station – Melitopol city)*

Month	Years of research								Standard precipitation rate
	2013	2014	2015	2016	2017	2018	2019	2020	
January	63.2	55.9	42.1	60.0	45.9	53.4	52.4	11.3	44.0
February	9.8	7.3	32.1	42.1	29.0	47.8	11.1	101.8	34.4
March	45.8	10.2	80.7	25.6	13.3	70.1	37.9	6.4	35.7
April	9.2	48.6	64.3	30.7	60.7	5.5	49.4	9.9	34.4
May	32.3	65.3	23.9	84.6	12.7	22.4	96.2	78.4	46.5
June	58.1	102.3	62.2	28.2	41.8	32.4	14.4	55.2	54.0
July	23.6	27.1	52.2	34.3	60.0	80.1	42.1	48.5	44.2
August	6.4	17.0	0.9	17.8	42.4	6.1	55.1	21.1	34.8
September	22.1	104.1	0.5	61.4	51.4	80.7	13.2	19.4	39.5
October	79.4	15.5	17.3	25.4	33.7	18.1	18.7	20.5	32.5

Table 1. Continued

Month	Years of research								Standard precipitation rate
	2013	2014	2015	2016	2017	2018	2019	2020	
November	13.8	18.8	71.1	38.7	18.0	36.8	19.5	16.0	37.8
December	7.4	69.9	12.0	26.1	18.5	74.3	31.7	29.1	42.8
Per year	370.1	542.0	459.3	474.9	427.4	527.7	441.7	417.6	480.6

Source: *compiled by the authors*

The annual amount of precipitation did not significantly differ from the long-term average, with the exception of an abnormally dry 2013, when precipitation was 23% lower. However, 2014 was quite wet for the Melitopol district – precipitation fell by 13% more than the long-term average norm. Winter conditions for all the years of research were favourable for natural grasses, since the air temperature, for the most part, was higher than the long-term average norm. In March, when the average daily air temperature rises above +5°C, perennial and winter natural grasses resume vegetation, seeds of early spring species germinate. During the research period, the average monthly air temperature in March was significantly higher than the long-term average norm, with the exception of 2018, when march was cold. The temperature conditions of April during all the years of research were also favourable for grass growth. The summer months during the study period were hot. Particularly severe heat and drought continued in June 2019, when the average monthly air temperature was 4.1°C higher than the annual average, while the amount of precipitation for the month was only 27% of the long-term average norm.

***Table 2**. Total precipitation, mm (according to the nearest weather station – Melitopol city)*

Month	Years of research								Standard precipitation rate
	2013	2014	2015	2016	2017	2018	2019	2020	
January	0.4	-1.6	-1.0	-3.0	-2.8	-0.7	-0.3	0.9	-1.9
February	2.5	0.1	1.0	3.8	-0.9	-0.3	1.0	2.2	-1.4
March	3.4	6.6	5.4	6.1	6.8	1.6	3.8	7.8	3.1
April	12.3	11.2	9.5	12.9	8.9	13.4	11.4	9.4	10.4
May	20.8	18.7	17.1	16.4	16.4	19.8	18.3	15.1	16.8
June	23.1	20.7	21.9	22.6	22.1	23.4	25.3	22.8	21.2
July	24.0	25.0	23.7	24.8	23.6	24.8	23.1	25.0	23.7
August	25.2	24.8	25.2	25.8	26.4	25.8	23.6	23.4	23.2
September	14.9	18.5	21.7	17.3	20.1	18.7	17.9	20.5	17.2
October	8.8	9.5	9.1	8.5	10.7	13.3	1.8	15.0	10.4
November	6.6	2.7	6.7	3.8	5.2	2.9	6.3	4.7	4.0
December	-0.4	0.1	2.2	-2.1	5.2	0.5	3.7	0.1	-0.1
Per year	11.8	11.4	11.9	11.4	11.8	11.9	12.2	12.2	10.6

Source: *compiled by the authors*

In terms of precipitation in March, the most favourable conditions for the germination of early spring species and the resumption of vegetation of winter and perennial species developed in 2013 and 2015. However, the following months of the growing season in 2013 were dry. In 2015, May was dry, and the severe drought lasted from August to December of that year. March 2018 was wet (precipitation was 196% of the annual average), but, as mentioned above, very cold. After the abnormally cold March 2018 for the Melitopol district, an abnormally dry April came (the amount of precipitation was 16% of the annual average). May and June of that year were also dry, which, respectively, affected the amount of terrestrial biomass of live mulch. In addition to 2018, 2016 and 2020 were unfavourable for the development of a dense stand of grasses – due to the drought that lasted during the two most important months for the development of grasses – March and April.

Description of the experimental site. The total area of the experimental plot of organic sweet cherries was 1.7 hectares. In 2011, the sweet cherry (*Prunus avium L.*) varieties Dilema and Valery Chkalov were planted on this territory. These two varieties are grafted on an extensive tall rootstock – mahaleb cherry (*Prunus mahaleb*). Scheme of planting cherry trees – 7×5 m. The shape of the crown of trees is a slender columella. Since 2013, the experimental plot of the orchard with an area of 0.9 hectares was kept under plant mulch (spontaneous vegetation cover). Vegetation was mowed 4 times during the growing season, and the mown mass was left on the soil surface. The rest of the plot area was kept under black fallow, and then – under the sowing of medicinal plants. During the care of black fallow, standard mechanical cultivation, one disking to a depth of 15 cm, and manual weeding during the growing season were carried out. Chemical protection of plants and application of mineral fertilisers were absent. On all sides, the site of organic sweet cherries was surrounded by field roads (4-6 m wide), which border the old forest belts on the east, north, and west (10-12 m wide, the trees were about 60 years old), and on the south side – with a field of grain crops.

Basic elements of accounting and observations. Species composition of grass cover plants; ecomorphs of species; abundance and occurrence of species in the experimental site; general aboveground phytomass of plant mulch; general projective soil cover with herbaceous plant communities. The species composition of the herbaceous plant communities was determined according to the generally accepted methods of studying the flora of vascular plants using keywords, atlases and reference books (Prokudin & Dobrochaieva, 1999; Lebeda, 2009; Lebeda, 2011; Mashkovska, 2015). Latin names of species were specified according to the nomenclature list of vascular plants of Ukraine (Mosyakin & Fedorochuk, 1999). Ecological certification of plant species was carried out based on the ecomorph classification (Tarasov, 2012; Baranovskij *et al.*, 2017). The abundance of plant species in live mulch was determined by counting the number of plant specimens of each species (in rhizomatous plants – the number of shoots) on temporary accounting plots with an area of 1 m² in a 6-time repetition with a random location on the experimental site of an organic garden (Abduloieva & Solomaha, 2011).

Occurrence of species was determined by the equation (1):

$$F = S_2/S_1 \times 100, \quad (1)$$

where F – occurrence, %; S_1 – number of accounting plots (in this study $S_1 = 10$); S_2 – number of sections where this species is present.

Common aboveground phytomass of plant mulch was determined 3 times during the growing season (May, July, and September) using the method of mowing to the ground level. The area of the accounting plot was 1 m². The repetition was 10 times with a random location of an organic cherry orchard on the experimental plot. The mown fresh mass was weighed, after which control samples were taken (in 3-time biological repetition), which were also weighed and dried to an air-dry state in a thermostat at a temperature of 105°C. Total dry phytomass of plant mulch (g/m²) was calculated considering the moisture content in fresh phytomass. The weight for three mows was summed up and taken as the value of the total aboveground dry phytomass for the growing season (g/m²). General projective soil coverage with herbaceous plant groups was determined visually using a 1×1 m grid with a 10×10 cm window. The grid was kept at the level of the grass stand, the grass cover on the accounting plot was considered (there were 10 accounting plots in total) and the number of grid cells accounted for plants and the soil surface free of plants was determined. Then they were recalculated in % of the soil surface. Determination was carried out 3 times during the growing season (May, July, and September), after which the average value of the total projective grass cover of the soil for the growing season was calculated (Abduloieva & Solomakha, 2011). Statistical analysis was performed using a general linear model using Minitab 19 software suite (Minitab Inc., State College, PA).

RESULTS

Anthropogenic human impact on natural ecosystems leads to impoverishment of biodiversity and degradation of landscapes. Discontinuation of tillage under such circumstances leads to colonisation of sites by invasive and adventitious species, which is confirmed by the experimental data obtained (Table 3).

***Table 3**. Bioecological characteristics of grass cover plant species in an organic sweet cherry orchard*

Plant families and species	Climamorphs	Biomorphs	Heliomorphs	Trophomorphs	Hygromorphs	Coenomorphs	Adventitious species
Amaranthaceae							
Amaranthus blitoides S.Wats.	T*	Ann	He	MsTr	MsX	Ru	+ I
Amaranthus retroflexus L.	T	Ann	He	MsTr	MsX	Ru	+ I
Apiaceae							
Daucus carota L.	THKr	Per	ScHe	OgMgTr	XMs	Ru	
Eryngium campestre L.	G	Per	He	MsTr	X	St	
Asteraceae							
Achillea micrantha Willd	HKr	Per	ScHe	OgTr	MsX	Sil Ps	
Achillea millefolium L.	HKr	Per	He	MgTr	XMs	Ru St	
Ambrosia artemisifolia L.	T	Ann	ScHe	OgMgTr	X	Ru	+ IQ
Anthemis arvensis L.	T	Ann	He	MsTr	MsX	Ru St	

Table 3. Continued

Plant families and species	**Climamorphs**	**Biomorphs**	**Heliomorphs**	**Trophomorphs**	**Hygromorphs**	**Coenomorphs**	**Adventitious species**
Crepis tectorum L.	THKr	Bien	He	OgMsTr	MsX	Ps St Ru	
Hieracium umbellatum L.	HKr	Per	ScHe	OgTr	MsX	St Ps	
Lactuca serriola Torner	THKr	Ann Bien	ScHe	MsTr	XMs	Sil Ru	+
Senecio vernalis Waldst. et Kit.	T	Ann	ScHe	OgMgTr	XMs	Ru	
Taraxacum officinale	HKr	Per	ScHe	MsTr	Ms	Ru Pr	
Tragopogon dubius Scop.	HKr	Bien	He	MsTr	MsX	Ru St	
Boraginaceae							
Cynoglossum officinale L.	HKr	Bien	He	MgMsTr	MsX	Pr Ru	+
Echium vulgare L.	HKr	Bien	He	MsTr	X	Ps St Ru	
Lycopsis arvensis L.	HKr	Per	ScHe	MsTr	MsX	Ru Pt	
Brassicaceae							
Arabidopsis thaliana (L.) Heynh.	HKr	Ann Bien	He	OgTr	XMs	Ps Ru	+
Barbarea vulgaris R.Br.	HKr	Bien Ann	ScHe	MsMgTr	Ms	Pr Ru	
Capsella bursa-pastoris (L.)	T	Ann	He	MsTr	XMs	Ru	+I
Descurainia Sophia L.	T	Ann	He	MsTr	XMs	Ru	+
Lepidium campestre	THKr	Ann Bien	ScHe	MsTr	XMs	Ru	
Caryophyllaceae							
Melandrium album (Mill.) Garcke	HKr	Bien	ScHe	MsTr	MsX	Ru SMn Pr	
Chenopodiaceae							
Chenopodium album L.	T	Ann	ScHe	MsTr	MsX	Ru	
Chenopodium polyspermum L.	T	Ann	ScHe	MsTr	MsX	Ru	
Convolvulaceae							
Convolvulus arvensis L.	G	Per	ScHe	MsTr	MsX	Ru	
Cuscutaceae							
Cuscuta campestris Junk.	T	Ann	He	Par	Ms	Pr Ru	+Q
Dipsacaceae							
Scabiosa ochroleuca L.	HKr	Per	ScHe	MsTr	MsX	Ps Pr St	
Euphorbiaceae							
Euphorbia stepposa Zoz.	HKr	Per	He	MgTr	X	Ru Cr Pt St	
Fabaceae							
Lotus Ucrainicus Klok.	HKr	Per	He	MgTr	XMs	St Pr	
Trifolium arvense L.	T	Ann	He	MsTr	MsX	Ru Ps St	
Vicia villosa Routh	HKr	Ann Bien	ScHe	MgTr	XMs	Ru SMn Pr	+I
Fumariaceae							
Fumaria officinalis L.	T	Ann	He	MsTr	XMs	Ru	+
Papaveraceae							
Papaver rhoeas L.	HKr	Per	ScHe	MsTr	Ms X	Pt St Ru	+
Plantaginaceae							
Plantago lanceolata L.	HKr	Per	He	MsTr	XMs	Pr St SMn Ru	
Poaceae							
Agropyron pectinatum (Bieb.) Beaux	HKr	Per	He	Ms Tr	X	St	
Agrostis capillaris L.	HKr	Per	ScHe	OgTr	Ms	Sil Pr	
Anisantha sterilis (L.)	T	Ann	ScHe	MsTr	MsX	Pr St Ru	+
Anisantha tectorum (L.)	T	Ann	ScHe	OgMgTr	MsX	Ps Ru	+
Apera spica - venti (L.) Beauv.	T	Ann	ScHe	OgTr	XMs	Ru Ps	+
Avena fatua L.	T	Ann	He	MsTr	MsX	Ru	+
Bromopsis inermis (Leys.) Holub	G	Per	He	OgMgTr	XMs	Ru Pr St	
Bromus arvensis L.	T	Ann	He	MsTr	XMs	Ru	+
Bromus squarrosus L.	T	Ann Bien	ScHe	OgMgTr	MsX	Ru Ps St	+
Cynodon dactylon (L.) Pers.	HKr	Per	He	MsTr	XMs	HalPr	+
Elytrigia repens (L.) Nevski	G	Per	ScHe	MsTr	Ms	Sil St Pr Ru	
Poa angustifolia L.	HKr	Per	ScHe	MsMgTr	MsX	Sil Pr St	
Poa pratensis L.	G	Per	He	MsTr	Ms	Pr	

Table 3. Continued

Plant families and species	Climamorphs	Biomorphs	Heliomorphs	Trophomorphs	Hygromorphs	Coenomorphs	Adventitious species
Puccinella distans (Jac q.) Parl.	HK r	Per	He	MsTr	XMs	Ru Hal Pr	
Setaria glauca (L.) Beauv.	T	Ann	He	MsTr	XMs	Ps Ru	+
Portulacaceae							
Portulaca oleracea L.	T	Ann	ScHe	MsTr	XMs	Ru	+
Ranunculaceae							
Delphinium consolida	T	Ann	ScHe	MsTr	MsX	SMn Ru	+
Scrophulariaceae							
Verbascum phlomoides	HKr	Bien	He	OgMsTr	MsX	St Ru	
Zygophyllaceae							
Tribulus terrestris L.	T	Ann	He	MsOgTr	MsX	Ps Ru	+

Note: *Abbreviations for Table 3: Climamorphs: HKr – hemicryptophyte; G – geophyte; Kr – cryptophyte; T – therophyte. Biomorphs: Ann (Annuus) – annual species; Bien (Biennis) – biennial species; Per (Perennis) – perennial species. Heliomorphs: He (Heliophiton) – heliophyte; ScHe – partially demanding of light. Trophomorphs: OgTr (Oligotroph) – oligotroph; MsTr (Mesotroph) – mesotroph; MgTr (Megatroph) – megatroph. Hygromorphs: Ms (Mesophiton) – mesophyte (a plant of medium-moist habitats); X (Xerophiton) – xerophyte (plant of dry habitats). Coenomorphs: Pr (Pratensis) – pratanthus (Meadow plant); Sil (Silvaticus) – silvanthus (forest landscape species); St (Stepposus) – stepanthus (steppe plant); SMn (Margosilvaticus) – silvomargoant (edge plant); Ps (Psammophyton) – psammophantus (sandy soil plant); Pt (Petrophyton) – petrant (plant of stony soils); Ru (Ruderatus) – ruderant (weed); Hal (Halophyton) – halophant (a species of saline soils and reservoirs with high mineralisation); Par (Parasitus) – parasite; I – invasive species; Q – quarantine species.*
Source: *compiled by the authors*

It has been established that the species composition of grass cover plants in an organic sweet cherry orchard includes representatives of 21 families. The most numerous families were Poaceae (15 species) and Asteraceae (10 species). The Brassicaceae family is represented by 5 species; Boraginaceae and Fabaceae – 3 species each; Amaranthaceae, Apiaceae, and Chenopodiaceae – 2 species each. Other families – Caryophyllaceae Convolvulaceae, Cuscutaceae, Dipsacaceae, Euphorbiaceae, Euphorbiaceae, Fumariaceae, Papaveraceae, Plantaginaceae, Portulacaceae, Ranunculaceae, Scrophulariaceae, Zygophyllaceae – are represented by one species. However, the abundance of species varied both within the family and over the years of research (Table 4).

***Table 4**. Abundance of herbaceous plant species in an organic sweet cherry orchard*

Plant families and species	Years of research							
	2013	2014	2015	2016	2017	2018	2019	2020
Amaranthaceae								
Amaranthus blitoides S. Wats.	Sol	Cop	Cop	Sp	Sp	Sol	Sol	Sol
Amaranthus retroflexus L.	Sol	Cop	Cop	Sp	Sol	-	-	-
Apiaceae								
Daucus carota L.	-	-	-	Sol	Sol	Sol	Sol	Sol
Eryngium campestre L.	-	-	-	-	Sol	Sol	Sol	Sol
Asteraceae								
Achillea micrantha Willd	-	-	-	-	-	Sol	Sol	Sol
Achillea millefolium L.	-	-	-	Sp	Cop	Cop	Sol	Sp
Ambrosia artemisifolia L.	Sol	Cop	Cop	Sp	Sol	-	-	-
Anthemis arvensis L.	-	Sp	Cop	Cop	Cop	Cop	Sp	Sp
Crepis tectorum L.	-	Sp	Sp	Sp	Sp	Sp	Sol	Sol
Hieracium umbellatum L.	-	Sp	Sp	Sp	Sp	Sp	Sol	Sol
Lactuca serriola Torner	Sol	Cop	Cop	Sp	Sol	-	-	-
Senecio vernalis Waldst. et Kit.	Sp	Sp	Cop	Cop	Cop	Cop	Sp	Sp
Taraxacum officinale	-	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Tragopogon dubius Scop.	-	-	-	Sol	Sol	Sol	-	-

Table 4. Continued

Plant families and species	Years of research							
	2013	2014	2015	2016	2017	2018	2019	2020
Boraginaceae								
Cynoglossum officinale L.	-	-	-	Sol	Sol	Sol	Sol	Sol
Echium vulgare L.	-	-	Sol	Sol	Sol	Sol	Sol	Sol
Lycopsis arvensis L.	-	-	Sol	Sol	Sol	Sol	Sol	Sol
Brassicaceae								
Arabidopsis thaliana (L.) Heynh.	Sp	Sp	Sp	Sp	Sol	Sol	-	-
Barbarea vulgaris R.Br.	Sp	Sp	Sp	Sp	Sp	Sol	Sol	-
Capsella bursa-pastoris (L.)	Sp	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Descurainia Sophia L.	-	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Lepidium campestre	-	-	Sp	Sp	Sol	Sol	-	-
Caryophyllaceae								
Melandrium album (Mill.) Garcke	-	-	-	Sol	Sol	Sol	-	-
Chenopodiaceae								
Chenopodium album L.	Sol	Cop	Cop	Sp	Sol	-	-	-
Chenopodium polyspermum L.	Sol	Cop	Cop	Sp	Sp	-	-	-
Convolvulaceae								
Convolvulus arvensis L.	Sol	Sp	Sp	Sol	Sol	Sol	Sol	Sol
Cuscutaceae								
Cuscuta campestris Junk.	-	-	Sol	Sol	-	-	-	-
Dipsacaceae								
Scabiosa ochroleuca L.	-	-	-	Sol	Sol	Sol	Sol	Sol
Euphorbiaceae								
Euphorbia stepposa Zoz.	-	Sol	Sol	Sol	Sol	Sol	Sol	Sol
Fabaceae								
Lotus Ucrainicus Klok.	-	Sol	Sol	Sol	Sol	-	-	-
Trifolium arvense L.	-	Sol	Sp	Sp	Sp	Sp	Sp	Sp
Vicia villosa Routh	Sol	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Fumariaceae								
Fumaria officinalis L.	-	Sol	Sol	Sol	Sol	Sol	-	-
Papaveraceae								
Papaver rhoeas L.	-	Sp	Sp	Sp	Sp	Sp	Sp	Sol
Plantaginaceae								
Plantago lanceolata L.	-	Sol	Sol	Sol	Sol	Sol	Sol	Sol
Poaceae								
Agropyron pectinatum (Bieb.) Beaux	-	-	-	-	-	Sol	Sol	Sp
Agrostis capillaris L.	-	-	-	Sp	Sp	Sp	Sp	Sp
Anisantha sterilis (L.)	Sp	Sp	Sp	Sp	Sp	-	-	-
Anisantha tectorum (L.)	-	Sp	Sp	Sp	Sp	Sp	-	-
Apera spica-venti (L.) Beauv.	-	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Avena fatua L.	-	Cop	Cop	Soc	Soc	Sp	Sp	Sp
Bromopsis inermis (Leys.) Holub	-	-	-	Sp	Sp	Sp	Sp	Sp
Bromus arvensis L.	-	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Bromus squarrosus L.	-	Sp	Sp	Sp	Sp	Sp	-	-
Cynodon dactylon (L.) Pers.	-	-	-	Sp	Sp	Sp	Sp	Sp
Elytrigia repens (L.) Nevski	Sol	Sp	Sp	Cop	Cop	Soc	Soc	Soc
Poa angustifolia L.	-	Sp	Sp	Sp	Sp	Sp	Sp	Sp
Poa pratensis L.	-	Sp	Sp	Sp	Sp	Sp	-	-
Puccinella distans (Jac q.) Parl.	-	-	-	Sp	Sp	Sp	Sp	Sp
Setaria glauca (L.) Beauv.	Sol	Sp	Sp	Sp	Sp	-	-	-
Portulacaceae								
Portulaca oleracea L.	Cop	Sp	Sp	Sol	-	-	-	-

Table 4. Continued

Plant families and species	Years of research							
	2013	2014	2015	2016	2017	2018	2019	2020
Ranunculaceae								
Delphinium consolida	-	-	Sol	Sol	Sol	Sol	Sol	-
Scrophulariaceae								
Verbascum phlomoides	-	-	Sol	Sol	Sol	Sol	Sol	-
Zygophyllaceae								
Tribulus terrestris L.	Sol	Sol	-	-	-	-	-	-

Note: *Soc (Socialis) – number of plants 100 units/m^2; Cop (Copiosus) – number of plants from 10 to 100 units/m^2; Sp (Sparsus) – number of plants ≤10 units/m^2; Sol (Solitarius) – number of plants from 10 to 100 units/ha*
Source: *compiled by the authors*

Thus, in the first year of research, after stopping soil retention in the black fallow mode, natural grasses did not create a dense cover in the garden. The study areas were dominated by *Portulaca oleracea* L. In the 2nd year, it was replaced by such species as *Amaranthus blitoides* S. Wats., *Amaranthus retroflexus* L., *Ambrosia artemisifolia* L., *Lactuca serriola* Torner, *Chenopodium album* L., *Chenopodium polyspermum* L., *Avena fatua* L. In the 3rd year of research, these species remained abundant at the experimental site. Two other species were also identified: *Anthemis arvensis* L. and *Senecio vernalis* Waldst. et Kit. In the 3rd year of research, the parasitic plant *Cuscuta campestris* Junk. was found in the vegetation. This species was present in grass cover also next year, despite systematic deletion (manually). In the fourth year, there was a decrease in the abundance of the following species: *Amaranthus blitoides* S. Wats., *Amaranthus retroflexus* L., *Ambrosia artemisifolia* L., *Lactuca serriola* Torner, *Chenopodium album* L., *Chenopodium polyspermum* L. At the same time, the abundance of *Elytrigia repens* (L.) Nevski and, especially, *Avena fatua* L. also increased. In the 5th year of research, the highest abundance rates were characterised by *Avena fatua* L., *Elytrigia repens* (L.) Nevski, *Senecio vernalis* Waldst. et Kit., *Anthemis arvensis* L., *Achillea millefolium* L. In the sixth year, abundance of *Avena fatua* L. decreased, and *Elytrigia repens* (L.) Nevski on the contrary increased. In the 7th or 8th year of research, *Elytrigia repens* (L.) Nevski was more abundant than the rest of the plant species in the experimental area. In addition to the abundance, an important indicator is also the occurrence of species at the experimental site, which is presented in Table 5.

Table 5*. Occurrence of herbaceous plant species in an organic sweet cherry orchard, %*

Plant species within families	Years of research							
	2013	2014	2015	2016	2017	2018	2019	2020
Amaranthaceae								
Amaranthus blitoides S. Wats.	20	80	70	30	20	10	10	10
Amaranthus retroflexus L.	30	90	80	40	20	-	-	-
Apiaceae								
Daucus carota L.	-	-	-	10	10	20	10	10
Eryngium campestre L.	-	-	-	-	10	10	10	10
Asteraceae								
Achillea micrantha Willd	-	-	-	-	-	10	10	10
Achillea millefolium L.	-	-	-	20	30	30	30	20
Ambrosia artemisifolia L.	30	100	90	60	30	-	-	-
Anthemis arvensis L.	-	50	100	100	100	80	60	30
Crepis tectorum L.	-	60	70	60	50	40	20	10
Hieracium umbellatum L.	-	40	30	30	40	20	10	10
Lactuca serriola Torner	10	30	30	20	10	-	-	-
Senecio vernalis Waldst. et Kit.	60	40	50	60	40	40	10	10
Taraxacum officinale	-	10	40	50	50	50	50	40
Tragopogon dubius Scop.	-	-	-	10	10	10	-	-
Boraginaceae								
Cynoglossum officinale L.	-	-	-	10	10	10	10	10
Echium vulgare L.	-	-	10	10	20	10	10	10
Lycopsis arvensis L.	-	-	10	20	20	10	10	10
Brassicaceae								
Arabidopsis thaliana (L.) Heynh.	80	90	100	100	60	50	-	-

Table 5. Continued

Plant species within families	Years of research							
	2013	2014	2015	2016	2017	2018	2019	2020
Barbarea vulgaris R.Br.	40	30	30	30	20	10	10	-
Capsella bursa-pastoris (L.)	100	100	100	100	100	70	60	50
Descurainia Sophia L.	-	100	100	100	100	100	70	30
Lepidium campestre	-	-	30	30	20	20	-	-
Caryophyllaceae								
Melandrium album (Mill.) Garcke	-	-	-	30	30	20	-	-
Chenopodiaceae								
Chenopodium album L.	30	100	100	40	30	-	-	-
Chenopodium polyspermum L.	20	60	50	30	20	-	-	-
Convolvulaceae								
Convolvulus arvensis L.	100	100	100	100	100	100	100	100
Cuscutaceae								
Cuscuta campestris Junk.	-	-	30	30	-	-	-	-
Dipsacaceae								
Scabiosa ochroleuca L.	-	-	-	10	10	10	10	10
Euphorbiaceae								
Euphorbia stepposa Zoz.	-	30	30	30	10	10	10	10
Fabaceae								
Lotus Ucrainicus Klok.	-	20	20	20	20	-	-	-
Trifolium arvense L.	-	30	50	60	60	60	100	100
Vicia villosa Routh	100	100	100	100	100	100	80	60
Fumariaceae								
Fumaria officinalis L.	-	100	100	100	80	70	-	-
Papaveraceae								
Papaver rhoeas L.	-	50	100	100	100	40	20	10
Plantaginaceae								
Plantago lanceolata L.	-	10	10	10	10	10	10	10
Poaceae								
Agropyron pectinatum (Bieb.) Beaux	-	-	-	-	-	50	80	80
Agrostis capillaris L.	-	-	-	50	50	60	60	60
Anisantha sterilis (L.)	30	30	40	40	40	-	-	-
Anisantha tectorum (L.)	-	40	50	50	40	30	-	-
Apera spica - venti (L.) Beauv.	-	30	40	50	50	30	30	30
Avena fatua L.	-	30	60	60	60	50	30	30
Bromopsis inermis (Leys.) Holub	-	-	-	30	50	60	60	60
Bromus arvensis L.	-	60	70	40	40	30	20	10
Bromus squarrosus L.	-	40	40	50	30	10	-	-
Cynodon dactylon (L.) Pers.	-	-	-	40	50	60	70	70
Elytrigia repens (L.) Nevski	100	100	100	100	100	100	100	100
Poa angustifolia L.	-	30	50	50	60	60	60	60
Poa pratensis L.	-	20	40	40	50	30	-	-
Puccinella distans (Jac q.) Parl.	-	-	-	30	50	60	70	100
Setaria glauca (L.) Beauv.	100	100	80	50	50	-	-	-
Portulacaceae								
Portulaca oleracea L.	100	60	40	30	-	-	-	-
Ranunculaceae								
Delphinium consolida	-	-	10	10	10	20	10	-
Scrophulariaceae								
Verbascum phlomoides	-	-	10	30	30	10	10	-
Zygophyllaceae								
Tribulus terrestris L.	30	10	-	-	-	-	-	-

Source: *compiled by the authors*

As a result of studying the occurrence of plant species in the organic garden, it was established that in the 1st year of research a high value of this indicator was characteristic of *Capsella bursa-pastoris (L.), Convolvulus arvensis L., Vicia villosa Routh, Elytrigia repens (L.) Nevski, Setaria glauca (L.) Beauv. and Portulaca oleracea L.* In the 2nd year of research, *Ambrosia artemisifolia L., Descurainia Sophia L., Chenopodium album L., Fumaria officinalis L. also had a high occurrence*. It should be noted that the occurrence of *Ambrosia artemisifolia L.* reached its maximum in the 2nd year after the termination of the black fallow regime, then gradually decreased, and in the 6th year this plant disappeared from the experimental site. The occurrence of *Anthemis arvensis L.* was high (100%) in years 3-5 of the study, and decreased in subsequent years. *Capsella bursa-pastoris (L.)* had a high (100%) occurrence in the first five years, and in subsequent years it decreased. *Descurainia Sophia L.* was 100% encountered from the 2nd to 6th year of research. *Chenopodium album L.* had a high occurrence (100%) only in the 2nd and 3rd years of research, and from the 6th year this plant disappeared from the experimental site. *Vicia villosa Routh* had a high occurrence (100%) in the first 6 years. *Fumaria officinalis L.* had the highest incidence within 2-4 years. *Papaver rhoeas L.* had a high occurrence value during 3-5 years of research.*Convolvulus arvensis L. and Elytrigia repens (L.) Nevski* had the highest occurrence during all the years of research.

Thus, as of the 8th year of the grass cover's existence on the experimental site in the organic cherry orchard (2020), it was possible to state the stage of segetal and ruderal species. The number of species was dominated by families *Poaceae* (10 species) and *Asteraceae* (7 species). Family *Boraginaceae* was represented by 3 species, *Apiaceae, Brassicaceae*, and *Fabaceae* – 2 types each, *Amaranthaceae*, *Convolvulaceae*, *Dipsacaceae, Euphorbiaceae, Papaveraceae* and *Plantaginaceae* – 1 type each. Control of invasive species in the herbal plant communities was achieved due to moderate application of mowing (4 times during the growing season). Due to this event, it was possible to get rid of the presence of such species as *Amaranthus retroflexus L., Ambrosia artemisifolia L., Lactuca serriola Torner, Tragopogon dubius Scop., Arabidopsis thaliana (L.) Heynh., Barbarea vulgaris R.Br., Lepidium campestre, Melandrium album (Mill.) Garcke, Chenopodium album L., Chenopodium polyspermum L.* Parasitic species *Cuscuta campestris Junk.* during the growing seasons of 2014 and 2015, was removed from the site by hand and burned outside the site, which helped to get rid of this quarantine plant.

As part of herbaceous plant communities, the total number of plant species that were determined in the course of research was 55 species (Tables 3, 4, and 5). However, the number of species present at the experimental site varied over the years (Fig. 1).

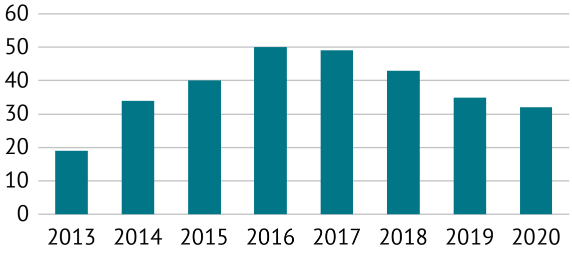

Figure 1. *Number of plant species in the composition of grass cover in the organic cherry orchard*
Source: *compiled by the authors*

In the first year of research, only 19 plant species were identified, in the next three years the number of species increased and in 2016 it was 50 species. In the future, the number of species tended to decrease and in 2020 amounted to 32 species. That is, starting from the 5th year of research, the species composition of plants of herbaceous plant communities gradually simplified. In the 1st year of research, the composition of herbaceous plant communities was dominated by therophytes, i.e., annuals that are restored from seed (Tables 4 and 5, Fig. 2 and 3).

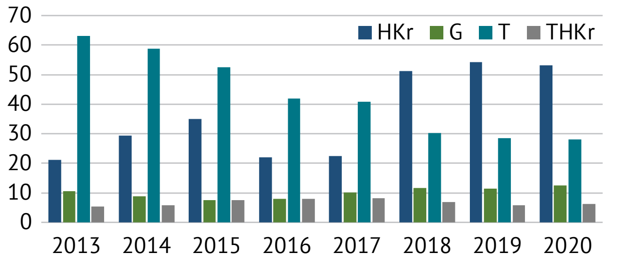

Figure 2. *Climamorphs of species in the composition of grass cover in the organic cherry orchard, % of the total number of species*
Note: **HKr – hemicryptophyte; Kr – cryptophyte; G – geophyte; T – therophyte*
Source: *compiled by the authors*

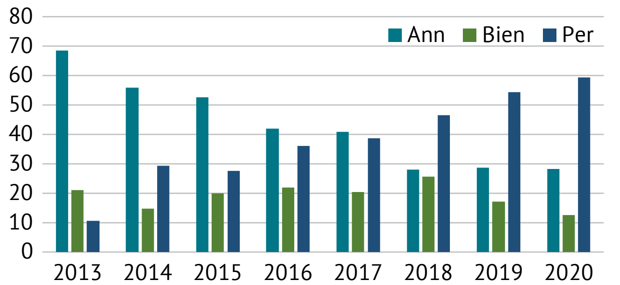

Figure 3. *Biomorphs of species in the composition grass cover in the organic cherry orchard, % of the total number of species*
Note: **Ann (Annuus) – annual plant; Bien (Biennis) – biennial plant; Per (Perennis) – perennial plant*
Source: *compiled by the authors*

In the following years, the number of therophytes steadily decreased (from 68 to 28%), and the number of hemicryptophytes (herbaceous perennials) – gradually increased. In 2020 (on the 8th year of research), the number of herbaceous perennials became 59% of the total number of plant species on the experimental site. This indicates that in the biocoenosis of the cherry orchard, a secondary succession of plants occurred as part of grass cover. Plant heliomorphs as part of herbaceous plant communities (Fig. 4) during the study period were represented by sciogeliophytes and heliophytes (approximately equally, with a small predominance of sciogeliophytes).

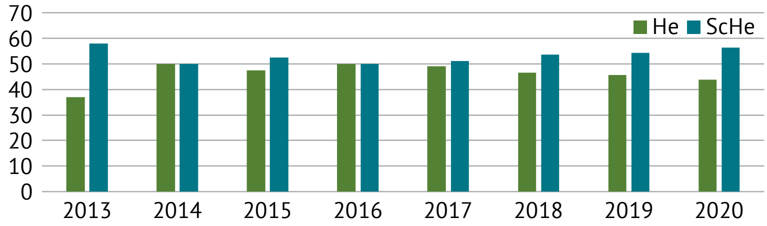

***Figure 4**. Heliomorphs of species in the composition of grass cover in an organic orchard, % of the total number of species*
***Note:** *Heliomorphs: He (Heliophiton) – heliophyte; ScHe – partially demanding of light*
***Source:** compiled by the authors*

Such properties of plants are logically related to the features of their place of growth, because this cherry orchard has quite wide row spacing (7 m) and a fairly large distance between trees in a row (5 m), which creates fairly good lighting conditions for natural grasses. In terms of nutrient requirements in the soil, the herbaceous plants in the organic sweet cherry orchard were mainly mesotrophs in all years of the study (Fig. 5).

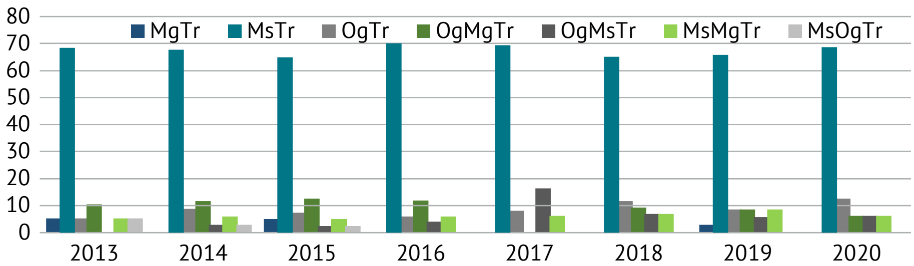

***Figure 5**. Trophomorphs of species in the composition of grass cover in the organic cherry orchard, % of the total number of species*
***Note:** * OgTr (Oligotroph) – oligotroph; MsTr (Mesotroph) – mesotroph; MgTr (Megatroph) – megatroph*
***Source:** compiled by the authors*

The percentage of mesotrophs ranged from 65 to 69% of the total number of species. In the 2nd, 3rd, and 4th years of research, 12-13% of plant species belonged to oligomegatrophs. In the 5th year of research, a significant share (16%) was made up of oligomesotrophs, in the 6th and 8th years – oligotrophs (12-13%). In the 7th year, none of the trophomorphs (except mesotrophs) reached the limit of 10% of the total number of species. Xeromesophytes and mesocerophytes were the most numerous in terms of moisture demand (Fig. 6).

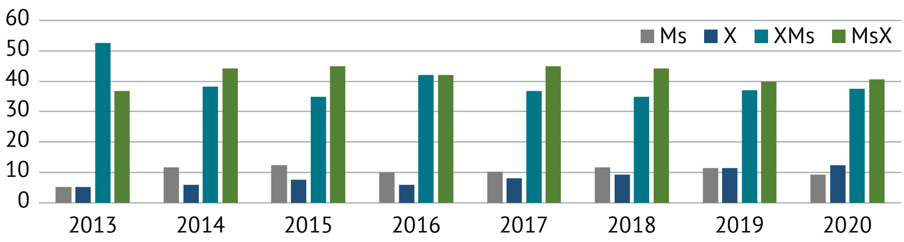

***Figure 6**. Hygromorphs of species in the composition of grass cover in an organic garden, % of the total number of species*
***Note:** *Hygromorphs: Ms (Mesophiton) – mesophyte (a plant of medium-moist habitats); X (Xerophiton) – xerophyte (a plant of dry habitats)*
***Source:** compiled by the authors*

Moreover, in the first year of research, xeromesophytes prevailed (53% of the total number of species). In subsequent years, mesoxerophytes prevailed (except in 2016, when the number of xeromesophytes and mesoxerophytes was the same). In 2020 (in the 8th year of research), the number of mesoxerophytes was 41%. However, the number of xerophytes has significantly increased – up to 12% of the total number of species. This indicates the competitive advantages of more drought-tolerant species in arid climates, regardless of the seed stock of other species accumulated during the wetter weather conditions of past decades. By changing the ratio of representations of various coenomorphs at the experimental site (Fig. 7) it is possible to judge the restoration of quasi-climaxic vegetation.

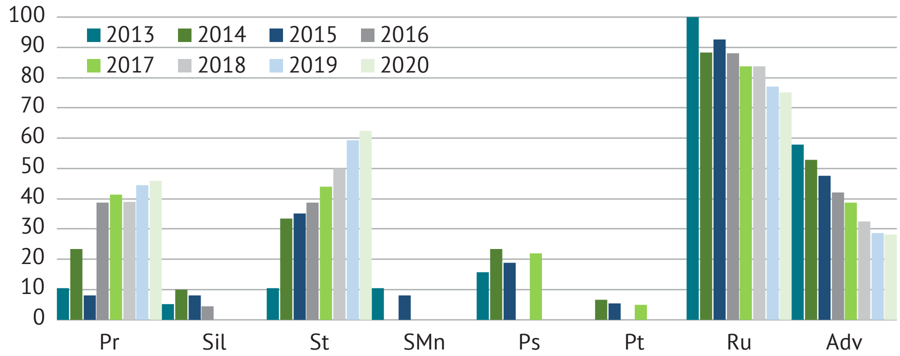

***Figure 7**. Coenomorphs of species in the composition of grass cover in an organic orchard, % of the total number of species*

***Note:** *Pr (Pratensis) – pratant (meadow); Sil (Silvaticus) – silvant (forest); St (Stepposus) – stepant (steppe); SMn (Margosilvaticus) – silvomargoant (edge species); Ps (Rsammophyton) – psammophant (sandy soil species); Pt (Petrophyton) – petrant (stony soil species); Ru (Ruderatus) – ruderanthus (weed); Adv – adventitious species*

***Source:** compiled by the authors*

Thus, the number of pratants increased over eight years of research from 11 to 46% of the species, stepants – from 11 to 64% of the total number of species that grew at the experimental site. At the same time, the number of adventitious species decreased from 58% to 28% of the total number of species. The number of ruderants, although it decreased over the years of research from 100 to 75%, remained large. This can be explained by the relatively short period of existence of the grass cover in an organic cherry orchard – only 8 years. Recovery succession is slow. The accumulation of biomass is an important indicator of ecosystem productivity, as the equivalent of the efficiency of using solar energy for the accumulation of organic matter, which will then be used to feed (and, accordingly, enrich the number and number of species) various participants in the biocoenosis, and to enrich the soil. Total aboveground biomass of plant mulch in the organic garden accumulated most intensively in the 3rd year of research, when the site was dominated by *Ambrosia artemisifolia L., Amaranthus retroflexus L., Lactuca serriola Torner, Chenopodium album L.* which can build up large biomass. This suggests the positive ecological role of these weeds (Table 6).

***Table 6**. Total aboveground dry phytomass of plant mulch for the growing season, g/m²*

Years of research							
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
215 ± 18	507 ± 43	865 ± 74	399 ± 37	463 ± 37	448 ± 38	566 ± 42	575 ± 59

***Source:** compiled by the authors*

In subsequent years of research, the value of the total aboveground phytomass of plant mulch experienced fluctuations, depending on weather conditions and the composition of plants in the experimental site. However, in the 7th or 8th year of research, this indicator stabilised and was 2.7 times higher than the total aboveground phytomass of plant mulch at the beginning of research in 2013. The overall projective coverage of the soil with grassy vegetation affects its ecological function of protecting the soil from overheating, freezing, over-drying, deflation, and water erosion. According to the data obtained (Table 7), the total projective coverage of the soil over the years of research was subject to fluctuations depending on climatic conditions, but it steadily increased over 8 years, and at the 7th-8th years it was 100%.

Table 7. Total projective coverage of the soil with plant mulch (average value for the growing season), %

Years of research							
2013	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**	**2013**
65 ± 9	72 ± 8	78 ± 7	82 ± 9	85 ± 5	93 ± 9	100 ± 9	100 ± 7

Source: *compiled by the authors*

Dense soil coverage became possible due to the development of such purely steppe species as *Elytrigia repens (L.) Nevski, Bromopsis inermis (Leyss.) Holub.*, *Poa angustifolia L.*That is, it can be stated that for 8 years the authentic flora was partially restored at the experimental site, judging by the presence of stepants (*Eryngium campestre L., Achillea millefolium L., Crepis tectorum L., Anthemis arvensis L., Echium vulgare L., Scabiosa ochroleuca L., Hieracium umbellatum L., Euphorbia stepposa Zoz., Trifolium arvense L., Papaver rhoeas L., Elytrigia repens (L.) Nevski, Plantago lanceolata L., Agropyron pectinatum (Bieb.) Beaux, Bromopsis inermis (Leys.) Holub, Poa angustifolia L.*), which formed a dense and beautiful soil cover in the cherry orchard (Fig. 8).

Figure 8*. Variety of grass cover in the organic cherry orchard, June 2017*
Source: *compiled by the authors*

Many of these species are classified as ruderants, as their presence in arable fields can significantly reduce the yield of cultivated plants. However, their presence in the garden can be useful for providing numerous environmental services, in particular: enriching the soil with organic matter, protecting against erosion, promoting the development of soil biota, attracting beneficial insects and pollinators. For example, *Taraxacum officinale* is classified as ruderant. However, it is this species, due to its early flowering (when the sweet cherry is not yet blooming), that plays a major role in the nutrition of pollinators, and *Osmia spp* itself. Such species as *Trifolium arvense L.* and *Vicia villosa Routh* are also considered ruderants. However, at the same time – these are very useful legumes for the soil, which, surprisingly, can grow on sandy soil without watering in hot and arid conditions.

From a practical (utilitarian) standpoint, all types of grass cover plants that were present at the experimental site in the 8th year of research have practical applications. Firstly, all of them have medicinal properties, even such species as *Achillea millefolium L., Elytrigia repens L., Papaver rhoeas L., Capsella bursa-pastoris L.* are officially recognised medicinal plants. Secondly, *Amaranthus blitoides S.Wats., Taraxacum officinale, Senecio vernalis Waldst. et Kit., Descurainia Sophia L., Capsella bursa-pastoris, Vicia villosa Routh, Agropyron pectinatum (Bieb.) Beaux, Trifolium arvense L., Agrostis capillaris L., Apera spica-venti (L.) Beauv., Bromopsis inermis (Leys.) Holub, Plantago lanceolata L., Puccinella distans (Jacq.) Parl., Elytrigia repens (L.) Nevski, Poa angustifolia L., Cynodon dactylon (L.) Pers.* are fodder plants. In addition, *Scabiosa ochroleuca L., Echium vulgare L., Lycopsis arvensis L.*, *Taraxacum officinale*, *Descurainia Sophia L.*, *Senecio vernalis Waldst. et Kit., Vicia villosa Routh* are honey plants. That is, the absolute majority of plant species in the composition of grass plant communities, as of the 8th year of research, in addition to environmental significance, had major practical importance. Unfortunately, in Ukraine, such species as *Vicia villosa* Routh, *Apera spica-venti* (L.) Beauv. and *Amaranthus blitoides* S. Wats. are recognised as invasive. However, further application of mowing may lead to the removal of these species from the biotope and their replacement with steppe species.

DISCUSSION

Researchers from different countries are engaged in research on key challenges related to the loss of biodiversity due to human economic activity and ways to solve them (Abuhasel, 2023). According to A. Kotelnytska *et al.* (2021), the priority area of the agricultural sector is not only to increase the volume of crop production, but also to maintain the stability of agroecosystems. This can be achieved by changing the way we farm and switching to organic production, which will contribute to achieving policy goals under the Kunming-Montreal Global Biodiversity System and the EU's Farm to Fork strategy (Sharma *et al.*, 2019; Wang *et al.*, 2023).

Human impact on Ukraine's steppe ecosystems has caused irreversible loss of biodiversity, and today the fragmented remnants of steppe vegetation in Ukraine account for less than 20% of the vegetation (Dubyna *et al.*, 2021). Ya.V. Koplyk (2022) confirmed a high degree of anthropogenic transformation of steppe biotopes on the territory of Ukraine. According to the researcher, for the normal functioning of ecosystems, it is a priority to study the dynamics of steppe vegetation as a result of anthropogenic transformation, climate changes, and load regimes. The impoverishment of the diversity of grass cover in the organic cherry orchard on experimental plots can be explained by the following reasons: firstly, due to competition of grasses with cherry trees; secondly, due to mowing. However, mowing in an industrial garden is necessary to make it easier for workers to take care of the garden. As for the competition of herbs with cherry trees, this issue was previously addressed in publications. The sweet cherry trees were suppressed by coexistence with grasses in the first 3 years after the grassing in the orchard. A significant decrease in the annual growth of the trunk diameter, the number and length of annual shoots was recorded. However, in subsequent years, the annual growth of shoots and leaf area was significantly larger in grassing conditions, compared to black fallow. In other words, the trees intensively created shading to suppress competitive vegetation. At the same time, the analysis of physiological and biochemical parameters of cherry leaves and fruits showed successful overcoming of stress from competition with herbs (Ivanova *et al.*, 2021).

Studies confirm the significant influence of soil fertility on plant growth and development, the species composition and diversity of plant communities (Tian *et al.*, 2023). In the studies conducted, the herbaceous plants in the organic sweet cherry orchard were mainly mesotrophs (65-69% of the total number of species). The high level of ruderants in plant communities at the experimental sites can be explained by the short period of existence of the grass cover (8 years) in the organic cherry orchard, since the recovery succession is slow. According to J. Zhang *et al.* (2023), the early stage of recovery succession lasts from 5 to 14 years. Restoration of phytocoenosis to quasi-climax (stable) state can last for several decades (Sărățeanu *et al.*, 2020). D.V. Dubyna *et al.* (2021) reported an increase in the level of coenotic diversity of ruderal vegetation in Ukraine over the past 30 years. Researchers explain this phenomenon by increasing the intensity and various types of anthropogenic loads on natural ecosystems.

Since invasive species are resistant components of the synanthropic fraction of flora in Ukraine, controlling their spread, monitoring, and studying bioecological features is an important task for the scientific community (Protopopova & Shevera, 2019). Mowing is recognised as an effective means of controlling invasive species (Minuto *et al.*, 2020). The lack of colonisation of the grass cover by invasive and quarantine species in the experimental areas of the cherry orchard can be explained by moderate mowing (4 times during the growing season). Control over invasive species is considered active recovery (Grašič *et al.*, 2023), and moderate mowing (or moderate grazing) as reported (Yang *et al.*, 2022; Kun *et al.*, 2024) accelerate recovery processes in the phytocoenoses of meadows and pastures (the so-called "moderate concern hypothesis"). In a global ecological sense, ruderants provide invaluable ecosystem services, namely, a dense cover of natural grasses mitigates the effects of climate warming, binds carbon and thereby reduces CO_2 emissions in the atmosphere (Berlinches de Gea *et al.*, 2023). The obtained findings are consistent with the data of other researchers regarding the attraction of natural pollinators – Osmia – by plant species of the grass cover. These species are considered the main pollinators of sweet cherries (Osterman *et al.*, 2023). The efforts of the international community are aimed at developing measures that promote pollinator conservation and crop pollination.

In the future, it is advisable to continuously carry out phytocoenotic monitoring of the species composition of plant communities under the influence of various stressors to fully understand the relationship between biodiversity and the stability of the agroecosystem.

CONCLUSIONS

In the arid conditions of the Southern Steppe of Ukraine on low-humus sandy loam soils, an organic cherry orchard is formed within 5 to 8 years and significantly depends on the species diversity and the state of populations of herbaceous perennials and annuals in row spacing. The species composition of herbaceous vegetation over the years of research was 55 plants belonging to different botanical families. The number of species in live mulch varied over the years, peaking in the 4th year of research – 50 species. In the future, the species composition of grass cover plants gradually simplified and in the 8th year numbered 32 species.

The most common floral composition of the grass cover and phytocoenotic activity of species in row spacing were found in families ***Asteraceae*** *(Achillea micrantha Willd,, Achillea millefolium L., Ambrosia artemisifolia L., Anthemis arvensis L., Hieracium umbellatum L., Crepis tectorum L., Lactuca serriola Torner, Senecio vernalis Waldst. et Kit., Taraxacum officinale, Tragopogon dubius Scop.);* ***Poaceae*** *(Agropyron pectinatum (Bieb.) Beaux, Agrostis capillaris L., Anisantha sterilis (L.), Anisantha tectorum (L.), Apera spica - venti (L.) Beauv., Avena fatua L., Bromopsis inermis (Leys.) Holub, Bromus arvensis L., Cynodon dactylon (L.) Pers., Bromus squarrosus L., Elytrigia repens (L.) Nevski, Poa angustifolia L., Poa pratensis L., Puccinella distans (Jac q.) Parl., Setaria glauca (L.);* ***Boraginaceae*** *(Cynoglossum officinale L., Echium vulgare L., Lycopsis arvensis L.);* ***Brassicaceae*** *(Arabidopsis thaliana (L.) Heynh., Capsella bursa-pastoris (L.), Barbarea vulgaris R.Br., Descurainia Sophia L., Lepidium campestre);* ***Fabaceae*** *(Lotus Ucrainicus Klok., Trifolium arvense L., Vicia villosa Routh);* ***Chenopodiaceae*** *(Chenopodium album L., Chenopodium poly spermum L.).* The composition of plant mulch in the first year of research was dominated by therophytes (annuals that are restored from seed). In subsequent years, the number of therophytes steadily decreased due to mowing of the herbage before the development of generative organs (from 68 to 28%), and the number of hemicryptophytes (herbaceous perennials) – gradually grew and in the 8th year of research accounted for 59% of the total number of plant species on the experimental site.

In relation to light, it was revealed that during the research period, plant heliomorphs in the herbaceous plant communities of the cherry orchard were represented by scyogeliophytes and heliophytes with a slight predominance of scyogeliophytes, that is, shade-tolerant plants. According to the requirements of plants for moisture, the most numerous were xeromesophytes and mesoxerophytes, the development of the aboveground mass of which depended on the hydrothermal conditions of the vegetation period. In terms of nutrient content in the soil, grass cover plants were mainly mesotrophs (65-69% of the total number of species) during all years of research. The change in the ratio of representations of various coenomorphs at the experimental site indicates the restoration of quasi-climaxic vegetation: the number of meadow plants increased over 8 years of research from 11 to 46% of species, steppe plants – from 11 to 64%, the number of adventitious or alien plant species decreased from 58 to 28% of the total number of species. The total aboveground phytomass of herbaceous vegetation fluctuated depending on weather conditions and species composition in the experimental area (from 215 to 865 g/m^2 of dry matter), but in the 8th year of research it was 2.7 times higher compared to the 1st year of research. The total projected soil coverage by populations of herbaceous annuals and perennials varied depending on climatic conditions, but gradually increased and reached 100% by the 7th-8th year. The findings of this study can be useful for establishing strategies for the natural restoration of agroecosystems of the Southern Steppe of Ukraine.

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CONFLICT OF INTEREST

None.

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Фітоценотична оцінка трав'яних рослинних угруповань органічного саду черешні

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Анотація. Втрата біорізноманіття є однією з глобальних екологічних проблем, з якими стикається людство. Інтенсивне використання природних ресурсів призвело до деградації ландшафтів і скорочення видового різноманіття рослинних угруповань. Тому пошук природних рішень для подолання цих викликів є актуальним питанням. Метою роботи було дослідження динаміки флористичного складу і ценотичної структури трав'яних рослинних угруповань природних трав у органічному саду черешні для стійкого функціонування агроландшафту. Динаміку ценотичного складу природних трав рослинного покриву у органічному саду черешні досліджували упродовж 2013-2020 рр. у посушливих умовах Південного Степу України на малогумусних супіщаних ґрунтах. Для вивчення видової різноманітності флори в органічному саду застосовували морфолого-еколого-географічні методи. Оцінку складу трав'яних рослинних угруповань здійснювали за допомогою традиційних методик геоботанічних описів. Наведено результати дослідження видового складу і ценотичної структури рослинних угруповань трав'яного покриву в органічному саду черешні. Задерніння саду природними травами привело до збагачення агроландшафтів корисними видами, які є важливими компонентами стійких сільськогосподарських систем і можуть виконувати екологічні послуги. Колонізації трав'яного покриву інвазійними і карантинними видами не спостерігали завдяки природним процесам демутаційної сукцесії і застосуванню помірного чотириразового скошування рослин за вегетацію (на висоту 15-20 см). У складі трав'яних рослинних угруповань на восьмий рік досліджень усі види були корисними, мали лікувальні властивості і слугували кормовою базою. Природні трави в органічному саду черешні є ресурсом біомаси і біорізноманіття. Фітоценотичний аналіз трав'яного покриву в органічному саду черешні дасть змогу обґрунтувати і запропонувати принципи прогнозування розвитку рослинних угруповань для оптимізації їх структури, поліпшення якості і підтримки біорізноманіття

Ключові слова: видовий склад; біорізноманіття; екологічні послуги; трав'яний покрив; ценоморфи; вторинна сукцесія; природне відновлення агроекосистем