

УДК 630*26:551.583

DOI <https://doi.org/10.32782/2226-0099.2026.147.1.11>

PECULARITIES OF FUNCTIONING OF FIELD SHELTERBELTS IN THE CONDITIONS OF CLIMATE CHANGE IN THE RIGHT-BANK FOREST-STEP

Viter N. G. – Doctor of Philosophy in Agronomy,
Senior Lecturer at the Department of Ecology and Environmental Protection,
Vinnitsia National Agrarian University
orcid.org/0000-0003-1436-9055

In today's conditions, one of the most pressing problems in the agricultural sector, which occupies 70 % of Ukraine's territory and determines its agricultural potential, is the stability and increased sustainability of agroecosystems. The creation and restoration of a system of field-protecting forest plantations is one of the most radical ways to maintain the sustainability of agroecosystems and increase their buffering capacity through the partial restoration of forest biogeocenoses, which are an integral part of natural landscapes. In order to determine the species composition of field shelter belts, it is necessary to conduct a comparative analysis of the phytocenotic structure and diversity of plantings, as well as to identify the main features of the formation of forest biocenosis in field shelter belts that ensure their biological stability.

Cultural biogeocenoses (field shelterbelts) are characterised by uniform spatial distribution and have four main layers in their vertical structure: the canopy layer, the shrub layer (undergrowth), the herb layer, and the ground layer (mosses and lichens). The horizontal structure of the biocenosis (mosaic) includes transitional zones from one phytocenosis to another, i.e. ecotones. In the vertical structure of the biogeocenosis of forest shelter belts, the greatest attention is paid to the study of the living above-ground cover of the herbaceous layer. The canopy layer of field-protecting forest belts, expressed by the composition of the stand, is determined by the forest culture project and, along with age, is decisive in the selection of sites in massive stands.

The stability and durability of field shelterbelts in agricultural landscapes with a mosaic horizontal structure is determined by the formation of forest biocenosis and enables succession processes and the formation of ecological niches. Therefore, a systematic approach and long-term observation are necessary to study the biocenosis of field protective forest strips (forest areas). The boundaries of the territory of the biocenosis of field shelterbelts are determined by an artificially formed tree layer of the phytocenosis.

Key words: field shelter belts, biogeocenosis, biodiversity, functioning, stability, climate change.

Viter N. G. Особливості функціонування полезахисних лісостіму в умовах зміни клімату Лісостепу Правобережного

У сучасних умовах однією з найактуальніших проблем в аграрному секторі, який займає 70 % території України та визначає її сільськогосподарський потенціал, є стабільність та підвищення стійкості агроєкоосистем. Створення та відновлення системи полезахисних лісових насаджень є одним із найрадикальніших способів підтримки стійкості агроєкоосистем та підвищення їх буферної здатності шляхом часткового відновлення лісових біогеоценозів, які є невід'ємною частиною природних ландшафтів. Для визначення видового складу полезахисних смуг необхідно провести порівняльний аналіз фітоценотичної структури та різноманітності насаджень, а також виявити основні особливості формування лісового біоценозу в полезахисних смугах, що забезпечують їх біологічну стійкість.

Культурні біогеоценози (польові захисні смуги) характеризуються рівномірним просторовим розподілом і мають у своїй вертикальній структурі чотири основні яруси: ярус пологу, чагарниковий ярус (підлісок), трав'янистий ярус і наземний ярус (мохи та лишайники). Горизонтальна структура біоценозу (мозаїка) включає перехідні зони від



© Viter N. G., 2026

Стаття поширюється на умовах ліцензії відкритого доступу CC BY 4.0

одного фітоценозу до іншого, тобто екотони. У вертикальній структурі біогеоценозу лісових захисних смуг найбільша увага приділяється вивченню живого надземного покриву трав'янистого ярусу. Ярус пологую полязахисних лісових смуг, виражений складом деревостану, визначається проектом лісової культури і, поряд з віком, є визначальним при виборі місць у масивних насадженнях.

Стабільність та довговічність польових захисних смуг у сільськогосподарських ландшафтах з мозаїчною горизонтальною структурою визначається формуванням лісового біоценозу та уможлиблює процеси сукцесії та формування екологічних ніш. Тому для вивчення біоценозу польових захисних лісових смуг (лісових ділянок) необхідний системний підхід та тривалі спостереження. Межі території біоценозу польових захисних смуг визначаються штучно сформованим деревним ярусом фітоценозу.

Ключові слова: полязахисні лісосмуги, біогеоценоз, біорізноманіття, функціонування, стійкість, зміна клімату.

Formulation of the problem. Interest in determining the biological functions of field shelterbelts is associated not only with the deterioration of their general condition in Ukraine over the past 15–20 years, but also with the aggravation of the problem of biodiversity loss. Having outlined the biological features of the functioning of field shelterbelts as a forest biogeocenosis, it is possible to determine the signs of its stability. Having considered the vertical structure of the phytocenosis of field shelterbelts – woody, understory, herbaceous and underground tiers, it is possible to analyze changes in the conditions of existence of the number of biota under climate change.

Analysis of recent research. The ideas of biocenology are laid down in the works of V. V. Dokuchaev, who proved the need to study all natural factors (soil, climate, moisture, organisms), which are comprehensive and mutually dependent. Biocenology and the doctrine of phytocenosis are the basis of one of the directions of science about forest types – biogeophytocenotic, the founder of which is V. M. Sukachev. In particular, his biogeocenotic approach considered the type of forest belts from the position of the systemic approach – the unity of the forest (biocenosis – the totality of phytocenosis and zoocenosis) and the environment (ecotype) [1, 2, 3, 4, 5, 6].

Artificially created phytocenoses are called cultural phytocenoses, in particular, forest shelterbelts are called stripocenoses, and the process of creating cultures of phytocenoses is called cultural anthropogenic successions. V. M. Sukachev in his scientific ideas gave impetus to the study of agrophytocenoses. Cultural biogeocenoses (forest shelterbelts) are characterized by uniformity of spatial distribution and in the vertical structure include 4 main tiers: crown tier, shrub tier (understory), grass tier, ground tier (mosses and lichens). In the horizontal structure of the biocenose (mosaicity) there are transitional strips from one phytocenose to another, i.e. ecotones) [2].

Forest ameliorator-topologist Professor V. D. Vorobyov (1952) highly appreciated the importance of typology for field shelterbelt afforestation work, since it opens up the opportunity to differentiate silvicultural techniques in accordance with the forest-vegetation conditions of the Forest-Steppe [2, 5]. The prolongation of natural forest types for steppes in accordance with Alekseev's typological grid, practiced by G. M. Vysotskyi, is an example of using the method of comparative ecology. The success of the growth of artificial forest-steppe plantations is determined by the successful selection of tree and shrub species, which can be facilitated by forest typology [3].

Therefore, an urgent task is to clarify the modern biological principles of the functioning of field shelterbelt forest agroecosystems in modern conditions of climate change.

The purpose of the study: The aim of the article is to study the species composition of forest shelterbelts, conduct a comparative analysis of the phytocenotic structure

of the diversity of stands, and determine the main features of the formation of forest biocenosis in forest shelterbelts as a means of determining their biological stability.

Problem statement. The methodological task in the study of ecosystems (biogeocenoses) of forest shelterbelts is a systemic approach, because all parts in the hierarchical structure of ecological systems, while uniting, give them new features and qualities, since the system is characterized by emergence [2]. Having considered the biological aspects of the functioning of forest shelterbelts, we identified signs of forest biogeocenosis in them. The vertical structure of the phytocenosis of forest shelterbelts – woody, understory, herbaceous and underground tiers are been studied.

Presentation of the main material. Field shelterbelts are narrow linear plantations that are characterized by stability, productivity and durability in the formation of a forest biocenosis in a certain territorially located biotope and under the conditions of the planned tree layer of the phytocenosis. Field shelterbelts are laid out in four, occasionally five rows up to 14 m wide, with two-row forest belts laid out in the middle of the fields. Forest belts are pure and mixed. Pure field shelterbelts mainly consist of one main plant species. When using slow-growing species (pine, oak), a fast-growing plant is introduced into the field shelterbelts to accelerate the functional effect. On chestnut soils, 20–30 % of shrubs are planted and alternated with trees of the main species. The distance between rows on gray forest soils is 3–4 m, and in a row – 1.5–2 m. Cultural biogeocenoses (field shelterbelts) are characterized by uniform spatial distribution and in the vertical structure include 4 main tiers: crown tier, shrub tier (understory), herb tier, ground tier (mosses and lichens). In the horizontal structure of the biocenosis (mosaicity) there are transitional strips from one phytocenosis to another, i.e. ecotones [2]. In the vertical structure of the biogeocenosis of forest shelterbelts, the greatest attention is paid to the study of the living aboveground cover of the herbaceous layer. The crown layer of field shelterbelts, expressed as an indicator of the composition of the stand, is determined by the design of forest crops and is decisive, along with age, when selecting plots in massive stands.

The aboveground cover is a vivid reflection of the changes occurring in the biogeocenosis and is an indicator of trophic conditions and moisture supply. In young and middle-aged field shelterbelts of various species composition, the process of anthropogenic succession of the cultural biocenosis from the agro-landscape to the agro-forest landscape is accompanied by qualitative changes that reflect the living aboveground cover with most of the sylvans, undergrowth, the presence of habitats for forest animals, avifauna, mushrooms, and forest litter. Accordingly, the ecosystem of field shelterbelts contains all components of the trophic chain – producers, consumers, and reducers, which ensure the circulation of substances, energy, and the development of the forest biocenosis. Evidence of favorable environmental conditions and the emergence of ecosystem relationships in field shelterbelts is the high productivity of the forest component of the forest belts.

As producers, field shelterbelts are the first link in various complex trophic chains, a center for biodiversity conservation, and therefore can serve as corridors, connecting fragmented areas of forest plantations. The works of modern scientists talk about forest biogeocenosis as a sign of a stable self-regulating plantation, therefore a forest shelterbelt can provide a complex of economic, environmental and social needs of society [22].

The biocenosis of natural forests and shelterbelts differs in species diversity at different times of the year. In summer, forests have a greater diversity of species than forest belts, and in winter – vice versa. A good example is «nomadic» birds, which fly to forest belts in large flocks to feed. In shelterbelts, there are three trophic groups of plant

producers: trees, shrubs and grasses. These are autotrophic organisms that form organic substances from inorganic substances during photosynthesis. Heterotrophs consume ready-made organic substances and are represented by herbivores (phytophages), predators (zoophages), detritophages. It is the decomposers that decompose organic substances into minerals and complete the cycle of substances. In shelterbelts, they are represented by microorganisms (bacteria, fungi), fly larvae, earthworms, beetles, microphages. In the forest shelterbelts, various types of mushrooms prevail. In the birch forest belt, there are russula, boletus, fly agaric, and milk mushrooms; in the pine forest belt, there are fly agarics and butter mushrooms; in the poplar forest belt, there are poplar rowan. This is explained by the fact that certain types of mushrooms grow under certain types of plants, forming mycorrhiza. In the forest belts, there are parasitic fungi – tinder fungi, which feed on living plants and destroy dead wood.

Field shelterbelts form a stable vegetation cover, shape the climate. They are an ecological factor that have a significant impact on the environment, and are a refuge and habitat for plants, animals, fungi, and viruses. An important feature of a natural ecosystem is species diversity, which forms populations. Species diversity is a manifestation of ecological contrast: the greater the number of species is, the more ecological niches are formed. The poorest in terms of the number of species is the poplar forest belt – 104 species. The species diversity of forest belts is closely related to the long-term vital activity of plant groups that prevail there. The younger the forest belts are, the more diverse and intensive is life in them. Populations of different species that exist in forest belts are not separated, but are interconnected by various relationships. As a result of these relationships between species that inhabit forest belts and are characterized by homogeneous living conditions, biocenoses are formed.

A sharp increase in the number of cenopopulations is observed in the ecotones of forest belts, which confirms the general ecological principle of the diversity of life on the border of the distribution of phases or environments according to V. I. Vernadskyi [1, 8]. In order to perform the functions of ecological corridors in ecological networks, it is important to assess the floristic similarity of natural nuclei and forest belts, and the process of plant migration is determined by favorable conditions for settlement [17]. The loss of shade forest stands and their division is accompanied by the spread of forest-steppe and synanthropic florocoenotypes in them. According to observations and estimates, field shelterbelts contribute to an increase in the species diversity of flora and fauna, including agroecosystems, by 18–20 %, entomofauna by 25–60 %, and zoofauna by 1–3 times [3]. Scientists have proven that forest stands up to 15 m wide in xerophytic conditions, due to the water regime, have positive growth, productivity and life cycle indicators compared to massifs. In the Forest-Steppe, the highest productivity on black soil is characteristic of poplar forest belts, and the longest life cycle is with common oak and its classic companions – maple, linden, pear [10]. Supplementing oak stands with common birch and sweet cherry increases productivity and accelerates the entry of stands into operation due to intensive current growth at a young age [3, 18–19].

Another direction in typology is edaphic (ecological), for which the expression of the gradient approach in comparative ecology is a simple graphic diagram of the Alekseev-Pogrebnyak edaphic grid, in which the horizontal axis reflects fertility, the vertical axis – soil moisture. The edaphic grid was supplemented with a climatic axis by D. I. Vorobyov [2, 5]. In the Right-bank Forest-Steppe zone, the basis of the phytocenosis of the field shelterbelts is made up of poplar, pine, birch, and hornbeam. The main species composition of the forest shelterbelts is supplemented by trees such as Siberian apple, prickly plum, and shrubs such as golden currant, and prickly rosehip [12].

The introduction of artificial coenoses of “phytocoenoses cultures” into agrolandscapes is accompanied by the changes in the composition of vascular plants that have zonal characteristics. In the Forest-Steppe, phanerophytes in the shelterbelts are mostly autochthonous, while for the plakor conditions of the Forest-Steppe, they are anthropophytes [1]. The recommended composition of species of shelterbelts for Polissya includes 16 species of tree species and shrubs (of which 75 % are autochthonous), 46 species (70 % autochthonous), and 25 species (30 % autochthonous) for the Northern Steppe [15]. Forest phytocoenoses in the Forest-Steppe include over 80 taxa, mostly introduced, among which some become adventitious, for example, the ash-leaved maple [13]. Most of the areas of forest shelterbelts in the southern steppe zone are occupied by robinia, gledicia, and ash stands. Only 8.1 % of the area is covered by oak stands [10, 14].

The approximation of the typological diversity of vascular plants in anthropocenoses to their zonal spectra is an important condition for the formation of heterogeneous agroecosystems [1]. Field shelterbelts, based on the typological diversity of vascular plants, approach to semi-natural ecosystems. Ecosystems are formed according to forest criteria with the participation of the main, accompanying and shrub species of autochthonous species [15, 16]. The introduction of introduced species (black walnut, Japanese sophora, northern oak, gledichia, robinia) into forest phytocenoses increases productivity, stability, and longevity in certain ecotypes, but the typological diversity of biota decreases [17].

Insects in field shelterbelts account for 53–75 % of biota species and their biomass exceeds the biomass of the other animal species. Insects play a dominant role in the circulation of substances, energy and information in terrestrial ecosystems. In the Forest-Steppe, against the background of a general decrease in the diversity of entomofauna in agrolandscapes by 40 % over the past decades, phytophagous life forms of dendrobionts account for about 300 species. The largest share among the perennial families that provide them with food is Fagaceae, Betulaceae, Calicaceae, Rosaceae. Many insect species are connected by trophic chains with plants belonging to several perennial families. Representatives of about 40 taxa of 8 orders of insects of the hortobiont order have been found. When approaching forest belts, their number increases by 4 times [18, 19, 20].

Forest litter, as a structural component of the forest biogeocenosis, forms trophic and topical connections of most components of forest autotrophs. Since the second half of the 20th century in artificial forest biogeocenoses of forest-steppe agrolandscapes, a significant increase in the number of individual species of avifauna (roak, magpie, gray crow, starling, great cormorant, yellow-billed martin, mallard, white-fronted goose) can be observed. Middle- and old-age forest-steppe shelterbelts are populated by new species – wolf, badger, raven, gray crow, magpie, owl, common turtledove, blackbird. Shrub-covered forest belts contributed to the appearance and settlement of warblers (gray, garden, and motley), nightingales and black-fronted magpies, and the stocking of artificial ponds led to the expansion of the ranges of piscivorous bird species (great cormorant, quack, gray heron, great and little grebes [21].

Conclusions and suggestions. The constancy and durability of field shelterbelts in agro-landscapes, which have a mosaic horizontal structure, are due to the formation of forest biocenosis and make it possible for succession processes and the formation of ecological niches to take place. Therefore, a systematic approach and long-term observation are necessary to study the biocenosis of field shelterbelts (forests). The boundaries of the biocenosis of forest shelterbelts are determined by an artificially created tree layer of the phytocenosis.

REFERENCES:

1. Краснов В. В., Шелест З. М., Давидова І. В. Фітоекологія з основами лісівництва: навч. посібн. Херсон : «Олді-плюс». 2014. С. 478.
2. Кучерявий В. П. Екологія. Львів : Вид-во «Світ», 2001. 500 с.
3. Tkachuk O., Viter N., Pankova S., Titarenko O., Yakovets L. The current environmental state of the field protective forest belts of the Forest Steppe of Ukraine. *International Journal of Ecosystems and Ecology Science (IJEES)*. 2023. Vol. 13 (2). P. 1–8.
4. Шанда Л. В. Аспекти степового лісознавства: біогеоценотичні парцели та їх періодична ектопічна система. *Грунтознавство*. 2006. № 3 (4). С. 84–91 http://www.ussj.cv.ua/2006_t7_3-4/Shanda.pdf (дата звернення 13.01.2026 р.).
5. Васенков Г. І., Іванюк І. Д. ю, Макарчук Я. І., Орлов О. О. Типологія лісу. навч. посіб. Житомир : Вид-во «Полісся», 2013. С. 244.
6. Лукіша В. В. Проблеми ползахисних лісосмуг у агроландшафтах України в контексті змін клімату. *Екологічні науки*. 2013. № 2 (25). С. 56–64.
7. Бурда Р. І., Трач С. Д. Антропогенні екотопи агроландшафтів та їх фітобіота. *Агроекологічний журнал*. 2004. № 1. С. 3–9.
8. Tkachuk O., Pantsyreva H., Mazur K., Chabanuk Y., Zabarna T., Pelekh L., Bronnicova L., Kozak Y., Viter N. Ecological problems of the functioning of field protective forest belts of Ukrainian Forest Steppe. *Ecological Engineering and Environmental Technology*. 2025. Vol. 26, Issue 1. P. 149–161.
9. Приходько С. А., Чіркова О. В. Ефективність функціонування лісосмуг як екологічних коридорів екомережі. *Промислова ботаніка*. 2009. Вип. 9. С. 25–31.
10. Гладун Г. Б. Значення захисних лісових насаджень для забезпечення сталого розвитку агроландшафтів. *Науковий вісник Укр ДЛТУ*. 2005. Вип. 15. С. 113–118.
11. Стадник А. П. Ландшафтно-екологічна оптимізація систем захисних лісових насаджень України: автореф. дис. на здобуття наук. ступеня д-ра с.г. наук. К. : Інст. агроекології, 2008. С. 46.
12. Лукіш В. В. Екологічні функції ползахисних лісових насаджень. *Екологічні науки*. 2013. № 1. С. 56–64.
13. Коломійчук В. П. Захисні лісосмуги як елемент екомережі степової зони України. *Екологічний вісник*. 2010. № 6. С. 55–62.
14. Фурдичко О. І., Стадник А. П. Лісові меліорації як основний фактор стабілізації степових екосистем. *Екологія та ноосферологія*. 2008. Т. 19, № 3 (4). С. 84–91.
15. Пилипенко О. І., Юхновський В. Ю., Ведмідь М. М. Система захисту ґрунтів від ерозії. К. : Златояр. 2004. С. 435.
16. Юхновський В. Ю., Малюга В. М., Штофель М. О., Дударець С. М. Шляхи вирішення проблеми ползахисного лісорозведення в Україні. *Наукові праці Лісівничої академії наук України*. 2009. Вип. 7. С. 62–65
17. Шестоपालов М. В. Шкідники агролісомеліоративних насаджень передгірного Криму і заходи, що обмежують шкідливість найбільш небезпечних видів: автореф. дис. на здобуття наук. ступеня канд. с-г. наук. 2005. С. 25.
18. Лісовий М. М., Чайка М. М., Екологічні заходи з удосконалення агроландшафтів для збереження і функціонування ентомологічного біорізноманіття в Лісо-степу. *Агроекологічний журнал*. 2007. № 4. С. 18–24.
19. Лісовий М. М., Чайка М. М., Ентомологічне різноманіття та його еколого-економічне значення. *Агроекологічний журнал*. 2007. № 4. С. 31–37.
20. Лісовий М. М., Чайка М. М. Ентомологічне різноманіття та його еколого-економічне значення. *Агроекологічний журнал*. 2007. № 4. С. 31–37.
21. Чегодаєва Н. Д., Каргін І. Ф., Астрадамов В. І. Вплив ползахисних лісосмуг на водно-фізичні властивості ґрунту і склад населення жужелиць прилеглих полів. *Екологічні науки*. 2012. № 1. С. 25–28.

22. Чіркова О. В. Структура лісосмуг як складових елементів екологічної мережі. *Проблеми екології та охорони природи техногенного регіону*. 2010. № 1 (10). С. 97–104.

23. Правила КМУ «Про затвердження Правил утримання та збереження полезахисних лісових смуг, розташованих на землях сільськогосподарського призначення» від 22 липня 2020 року № 650. <https://zakon.rada.gov.ua/laws/show/650-2020-%D0%BF#Text> (дата звернення 13.01. 2026 р.).

Дата першого надходження статті до видання: 14.01.2026

Дата прийняття статті до друку після рецензування: 13.02.2026

Дата публікації (оприлюднення) статті: 13.04.2026
