ŽEMĖS ŪKIO MOKSLAI. 2014. T. 21. Nr. 1. P. 9–16

Agroecological evaluation of the state of the fallow lands in Small Polissya of Ukraine

Zhanna Samchuk

National University of Water Management and Nature Resources Use, 11 Soborna Street, Rivne, Ukraine, 33000
E-mail: funtik_85@ukr.net

As a result of carrying out the land reform in Ukraine, 5–8.5 million hectares of arable land, fully regenerated into fallow lands, were withdrawn from the active agricultural usage.

The purpose of our researches was evaluation of the vegetation and soil cover's agroecological state of the fallow lands in the natural area of Small Polissya on different stages of successive changes.

Route investigations and layout of control areas resulted in finding out the composition of species, bioecological structure, stages of successive changes, feeding value and bioproductivity of vegetation.

The basic agricultural chemistry indexes of selected soil samples were determined in the laboratory conditions.

Key words: humus content, weeds, productivity of vegetation cover

INTRODUCTION

Carrying out the land reform in Ukraine caused changes in the structure of land users and land owners that resulted in substantial reduction of arable areas. Beginning from 1990, in Ukraine according to different estimations 5–8.5 million hectares of arable land which is fully regenerated into fallow lands were withdrawn from tillage (Chaika, 2003). In particular, in the Ternopil area 28.4 thousand hectares of tillage were taken out of the active use for the period of realization of the land reform according to the projects of the land arrangement in relation to organization of the territory of the land stakes (shares).

A number of leading scientists of the past devoted their works to learning of the processes of the vegetation cover's renovation on the fallow lands (Vysotskiy, 1915; Kostychev, 1886; Pavlovych, 1892; Sukachev, 1916; Cherniaev, 1959). But the processes of the cover renovation were considered, as a review, interconnections between soil and vegetation were left not revealed completely, and the methods of controlling and stimulating of the productivity renovation of these lands were not suggested and not founded. Today the most famous works in this direction are the works by B. Y. Yakubenko (2007), A. V. Bogovin, S. V. Dudnyk (2003), A. V. Bogovin, M. M. Ptashnik (2006). The changes in weed communities in Europe were analysed in many published works (Baessler, Klotz, 2006; Lososova, Simonova, 2008; Tyser et al., 2009). After the leading out of the landed lands from the active agricultural use mainly uncontrolled processes of renovation in a vegetation covering began on them. Reproduction plays an important part in the life of plants as it provides self-supporting of the totalities in the conditions of the surrounding which transforms constantly (Zlobyn, 2009). Holding the occupied territory by the vegetation totality provides vegetative reproduction while generative reproduction contributes to occupation and settling on new territories. It is peculiar to the eutherophytes to have plenty of seeds, which are producted during a vegetation period, easily carried on to nearby areas, that contribute to the

spreading of weeds far beyond the fallow (Buisson et al., 2006; Pashkevich, 2011).

As it is known, the type of vegetation is predetermined with ecological conditions and seminal base connection with low fertility of the lands withdrawn from intensive till and erosive processes, for a vegetation cover there is a characteristic mosaicism, small projecting coverage. The composition of species is presented mainly by one-year weeds, the seeds of which are present in the soil in a great number.

Physiological activity of microorganisms of the majority among investigated groups of one-year fallow is also far less than the analogous index of a long-term fallow land. Microbiological processes in the soil of one-year fallow pass by with less intensity: processes of exploration of organic substance are up to 21%, mineralization of organic nitrogen is up to 41% (Malynovska, Bogovin, 2009).

Often fallow lands become a growing place of poisonous, quarantine types of plants, a source of spreading diseases of plants and man. It characterizes the observed territories as being transformed enough (Burda, 1996).

Rather often fallow lands become the place of spontaneous tending of animals. Non-standardized pasqual load results in decreasing of general floristic variety, changes in ontogenetic structure, lowering of vitality index of the totalities of the major cenosis-forming species of grass on pastures (Bondareva, 2004; Koroviakova, 2011). As a whole, weakening of the reproductive attempt among cereals and increasing of this index among beans and variety of grass are observed (Bondareva, Kyrylchuk, 2012).

In connection with low fertility of soils the process of renovation of natural vegetation on fallow lands takes place very slowly. For a complete stabilization, recreation of biovariety, structure and productivity, 15–25 years are necessary (Bogovin, 2007). All the time fallows remain as ecologically unstable areas.

Consequently, a problem consists in the feasible managements of renovating processes of the vegetation cover on fallows with the purpose of term reduction of formation of climaxed groupments of vegetation aborigines, non-admission of distribution of quarantine and adventitious types of plants, increase of the productivity of grass. For this purpose, above all things, it is needed to estimate the real state of the ground-vegetation cover on fallows.

Therefore, the purpose of our researches was studying of the real state of the fallow lands in the natural area of Small Polissya on different stages of successive changes.

The task of our research is an analysis of the composition of species, bioecological structure, feedvalue and bioproductivity of a vegetation cover, and also a determination of basic agricultural chemistry indexes of soils on the control areas of the investigated fallows.

METHODS AND CONDITIONS

During 2009–2013 typical fallow lands of the first, third and seventh years, which were on different stages of successive changes within the limits of the north part of the Kremenets administrative district of the Ternopil region which belongs to the natural area of Small Polissya, were inspected (geographical coordinates 50°06'04"N, 25°44'12"E). The composition of species, bioecological structure, a stage of successive changes, feeding value and bioproductivity of grass were found.

To find the above-mentioned indexes a route method was used, which included two stages. On the first stage we got to know the peculiarities of the place and borders of the fallow lands. The second stage was a detailed route investigation during which the routes of different configuration were set up and control areas were put up, according to the principle of representativity. The control areas were 5 × 5 m^2 in size and were put up in thrice-repeated repetition. All researches were held in July–August during 2009–2013.

The identity of species is conducted after "Determinant of Superior Plants of Ukraine" (Dobrochaeva, 1999), "Atlas of the Most Widespread Weeds of Ukraine" (Melnychuk, Kovalivska, 1972), and "Atlas of Weed, Herbs and Honey Plants" (Vereshchahyn, 2002). Synanthropic kinds were determined according to the publications of V. V. Protopopova (1991). During the selection of life-form of geophytes according to the forms of growth and duration of life cycle the system of life-forms of Y. H. Serebriakov was accepted (1962). For the determination of the feeding value of grass we used the method of V. A. Solomakha and L. S. Balashov (1995), and also we conducted it in

parallel the point estimation of the feeding value offered by A. V. Bogovin (2006). The feeding value of separate kinds was set after a scale of E. Klapp (1961). The stages of successive changes are given according to the classification of B. Y. Yakubenko (2007).

Also on the fallows the basic agricultural chemistry indexes of soils were determined. Control areas are placed on the typical elements of relief with the most widely spread soils in the region of Rendzinas. The selection of soil samples was done according to SSU ISO 10381-1:2004 (State Standards of Ukraine). The samples were selected during the route researches of the fallows on the control areas in thrice-repeated repetition. Hydrolysis and exchange acidity (according to Kapen), the content of humus (according to Tuirin), and the content of potassium and phosphorus (according to Machyhin) were defined in the selected samples of soil (Arynushkyna, 1970). The statistical processing of information is conducted after B. Dospekhov (1985).

RESULTS AND DISCUSSION

Analysis of the vegetation cover. The first stage of successive changes in a transition from a fallow land to a stable climax phytocenoze is a weed one. The composition of species of pioneering vegetable groupments on a fallow land is determined by two sources: by the bank of seeds, which was formed in the layer of soil under cultural sowing-predecessors, and by the seeds which got there by different methods of transfer from adjoining territories. The determinative of the development of those or other vegetation groupments on a fallow is also agroecological and agricultural chemistry indexes. On the first year of successive changes of a fallow land the prevailing of eutherophytes is clearly seen, especially at the stage of sprouts which form fully covered areas in some places (Fig. 1).

The characteristic feature for a weed stage is high dynamics of the vegetation cover, during the vegetation period there is a frequent change of phases which form the series of successive changes. These processes are caused by competitive activity for the climatic and edaphic resources, by the life cycle of separate types of plants. Such basic phases of successive changes during the first year of the fallow land as *Chenopodium album* L., *Galinsoga parviflora* Cav., *Erigeron canadensis* L., *Cirsium setosum* Bess. were found out by us.

The distinguishing feature of the weed stage of successive changes is high share in the composition of species of the vegetation cover of synanthrops. In particular, in the grass of the most of the inspected first-year fallows there were the advents-kenophyts: *Ambrosia artemisiifolia* L., *Amarantus retroflexus* L., *Erigeron canadensis* L., *Torilis arvensis* Link., *Stenactis annua* Ness. Exactly the weed stage is the most aggressive and the most productive in spreading out of synanthropic types of plants, including quarantine ones, on

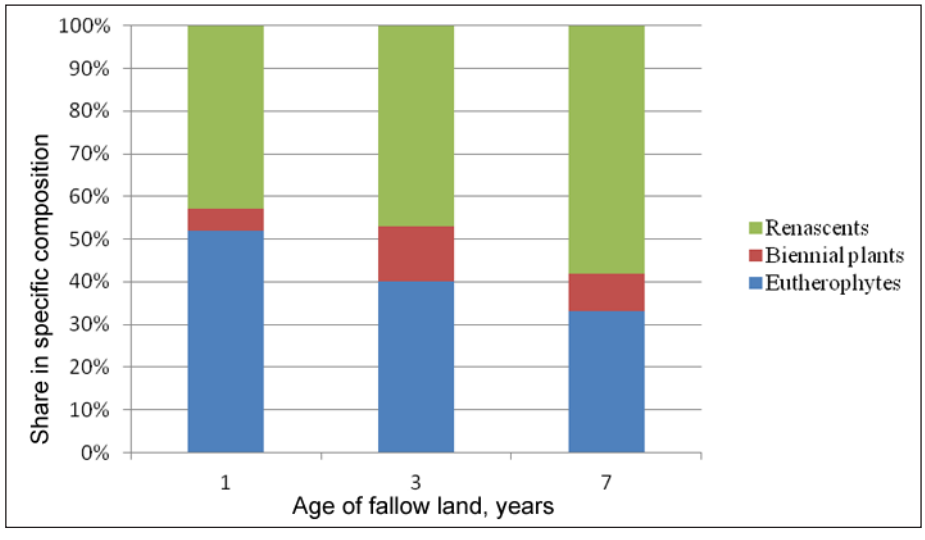

Fig. 1. Dynamics of the composition of species in the vegetation cover of Small Polissya fallows

adjoining territories. Therefore, fallows are the cells of synanthropization. Absence of any control on the part of main relation to the phytosanitary state of newlyformed fallows contributes to it. As a result, synanthrops go through all the cycles of development and produce seeds which have high vitality and various adaptations for spreading. Their high reproductivity and unpretentiousness to the conditions of the place of their growing, resistance to anthropogenic influence promote their settling on new territories.

The rhizome stage of successive changes is characterized with appearance and prevailing of rhizome cereals. In particular, on the probed territory, a high part in the projective coverage of *Elytrigia repens* (L.) Nevski was found. The amount of biennial plants is increased in the vegetation cover, cereals prevail among the eutherophytes: *Setaria viridis* (L.) Beauv., *Setaria glauca* (L.) Beauv. Biennial plants are presented with the phases of successive changes: *Melilotus albus, Melilotus officinalis, Taraxacum officinale*.

The rhizome and soft bush stage is presented by multicomponent phytocenozes with a considerable part of renascents. Subsequent development of cereal groupments which form a matte is observed. The composition of the species of the vegetation cover continues to be stabilized, cenotic intercommunications appear inside phytocenozes, a reproductive ability of grass grows.

Phytocenozes with prevailing *Stenactis annua* Nees. and *Solidago virgaurea* L. that form dense undergrowth are characteristic of the district of researches.

For the main form of growth in the content of the vegetation cover of all inspected territories prevailing of grassy plants is traced. The leading biomorphes of vegetation of fallow lands in Small Polissya are eutherophytes with the cored type of rootage. It testifies about making progressing influence of anthropogenic factors on the vegetation-ground cover.

On the second place in the spectrum of biotypes according to the duration of life cycle there are renascents among which grassy polycarbonates prevail. It proves that settling of new ecotopes is carried out more successfully at kinds which historically are more adapted to the survival in anthropogenically changed conditions due to their life-form.

Taking into account the growth of the continentality of microclimate, diminishing of relative humidity and increasing of the day's amplitude of the temperature of air, we set an ecological structure of vegetation of fallows in the context of its adaptation to the conditions of illumination and moistering.

It was discovered by us that geliofits considerably prevail above other geliomorfs. On the fallow lands of the 1st year their part is 65.4% and diminishes to 43.5% on the 7th year accordingly. It is explained by the fact that fallows are themselves opened anthropogenic ecotopes with a grassy vegetation.

The spectrum of hydromorfs of the inspected region distinguishes with the highest variability. It can be explained by various sources of moistening of the territory and by the peculiarities of microrelief, the structure of the ground cover. Among hydromorfs on the 1st year fallow lands the xeromesophytes prevail. On the 7th year of successive changes of the fallow the share of mesophytes is increased – 65.2%.

On the initial stages of successive changes fallows are characterized with the least feeding value. On the seventh year of overgrowing the composition of species is stabilized, valuable forage kinds appear, a biovariety is increased and stable enosis is formed. The feeding value of such fallows grows to category II, but it, however, remains still low because of the insignificant projecting coverage of vegetation species.

In the spectrum of economic groups of plants with the increase of duration of the overgrowing period the part of cereals grew and the amount of various kinds of grass decreased. Bob plants are present in grass of all refurbishable phytocenozes, but their projective coverage is rather insignificant and almost does not influence forage qualities of areas.

Analysis of soil. It is known that between the soil and the vegetation cover there is a constant reciprocal influence. In order to find out if there is a connection between the basic indexes of the soil fertility and the speed of renovation in the vegetation cover on fallow lands we defined and analysed basic agricultural chemistry indexes. To characterize the speed of renovation in vegetation we chose the index of bioproductivity of grass. The size of the phyto masses above the ground was estimated

with the method of trial mowing on the put-up control areas (Yhlovykov, 1971).

The results of the analysis of the ground samples taken from typical control areas of inspected fallow lands showed that with the increase of duration of the fallow the content of mobile forms of phosphorus also grows on the average to 38 mg kg^{-1}. Increasing of the content of mobile phosphorus on fallows can be explained by piling up of the considerable amount of organic matter from vegetable remains during mineralization of which the accessible for plants forms of phosphorus free oneselves, by absence of bearing-out by agricultural cultures. The content of mobile potassium is 111.22–115.73 mg kg^{-1}. With the growing of duration of staying of soils in the state of the fallow we fixed increasing of the content of potassium by 5–8 mg kg^{-1}. It is found that the duration of the fallow land does not influence the indexes of hydrolytic and exchanging acidity.

We also defined the content of humus in soil. According to the data received the fallows of the first year is the least provided with humus, humus concentration in the 25 cm layer of the ground is from 1% to 2.9%. The fallow lands of the seventh year of successive changes are characterized by the biggest content of humus – 3.35–4.58%. It can be explained by the accumulation of tails of plants which remain after finishing of the vegetation period on the fallow, by deceleration of mineralization and activation of the processes of humification in soil in connection with the absence of its tillage. We also set a direct dependence between the indexes of the content of humus and bioproductivity of soils on all inspected fallows (Figs. 2–4).

According to the results of our researches a high maintenance of humus in soil provides a high index of grass bioproductivity of a fallow land. In particular, at the minimum content of humus

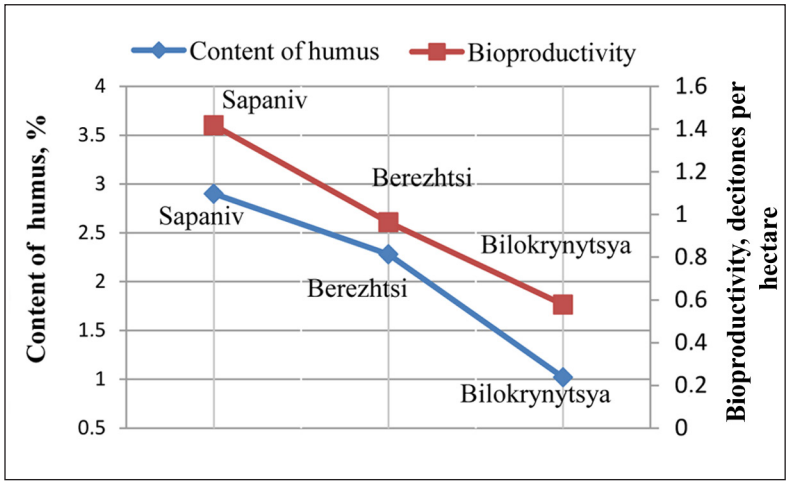

Fig. 2. Fallows of the 1st year
Correlation Coefficient = 0.971153
R-squared = 94.3139 percent
Standard Error of Est. = 0.14179
Mean Absolute Error = 0.0757317
Bioprod1 = 0.105774 + 0.42623•humus1

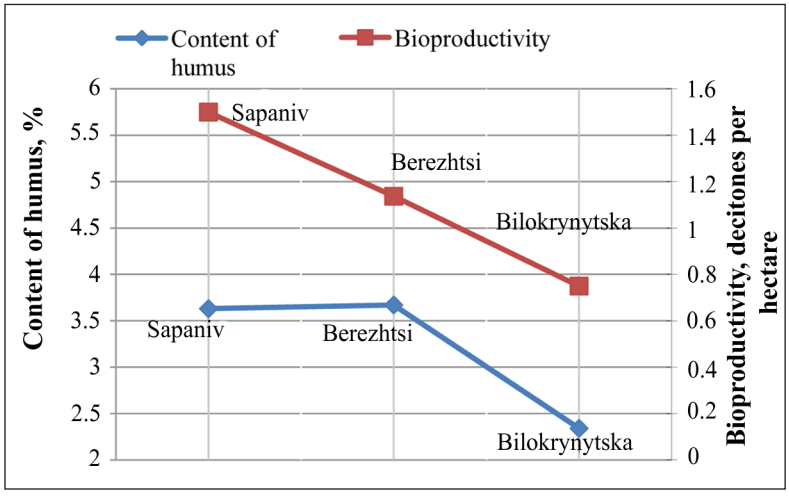

Fig. 3. Fallows of the 3rd year
Correlation Coefficient = 0.862016
R-squared = 74.3071 percent
Standard Error of Est. = 0.26886
Mean Absolute Error = 0.128632
ioprod3 = 0.244137 + 0.427325•humus3

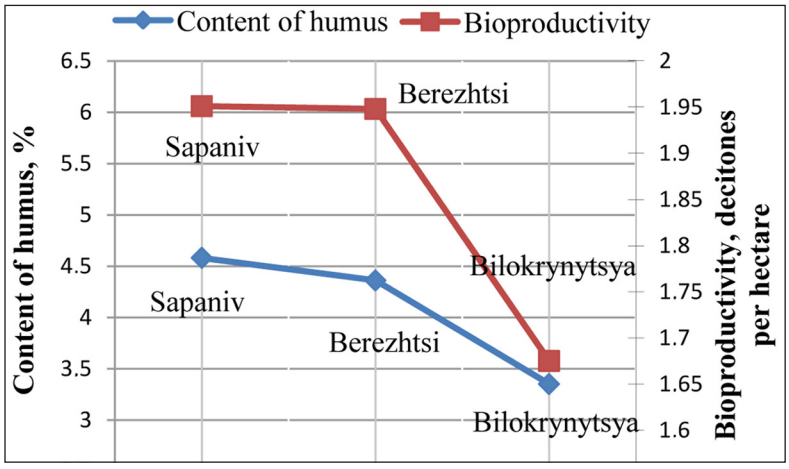

Fig. 4. Fallows of the 7th year
Correlation Coefficient = 0.987381
R-squared = 97.492 percent
Standard Error of Est. = 0.0354957
Mean Absolute Error = 0.018116
Bioprod7 = 0.880618 + 0.23858•humus7

1.02% on the fallow of the first year we also observed the least bioproductivity – 0.578 centner from one hectare.

CONCLUSIONS

Fallow lands are ecologically unstable areas, carrying a threat to the phytosanitary state of nearby lands, and also become a reason of diseases of animals and humans. They remain such ones to complete renewal of climax phytocenozes.

For the pioneering weed stage a high dynamic of a vegetation cover is characteristic, during the vegetation period there is a frequent change of phases which form the series of successive changes: *Chenopodium album* L., *Galinsoga parviflora* Cav., *Erigeron canadensis* L., *Cirsium setosum* Bess. A distinguishing feature is a high part in the composition of species of the synanthrop vegetation cover. The rhizome stage of successive changes is characterized by prevailing of rhizome cereals. On the investigated territory *Elytrigia repens* (L.) Nevski biennial plants are represented by the phases of successive changes: *Melilotus albus* Medic., *Melilotus officinalis* (L.) Pall., *Taraxacum officinale* Web. ex Wigg. The rhizome and soft bush stage is presented by multicomponent phytocenozes with a considerable part of renascents. Phytocenozes with prevailing of *Stenactis annua* Nees. and *Solidago virgaurea* L. are characteristic of the district of researches.

The leading biomorphes of the fallows of Small Polissya are eutherophytes with the cored type of rootage and renascents among which grassy polycarbonates prevail. The vegetation cover has signs of "xerophytization".

The feeding value depends on the stage of becoming alkaline of the fallow land and the composition of species. A connection between the feeding value and biovariety on fallows is observed – the category of feeding value grows with the increase of amount of species. On the whole, the fallows of Small Polissya of Ukraine are characterized with the low and middle feeding value of grass and belong to land categories I and II.

With the increase of the fallow duration the content of mobile forms of phosphorus in soils grows on the average on 38 mg kg^{-1} and of potassium on 5–8 mg kg^{-1}. A direct cross-correlative dependence is set between the indexes of the content of humus and bioproductivity of soils on all inspected fallow lands. Duration of the fallow does not influence the indexes of hydrolysis and exchange acidity.

Received 6 December 2013
Accepted 13 March 2014

REFERENCES

1. Arynushkyna E. V. 1970. *Rukovodstvo po khymycheskomu analyzu pochv*. MHU: Moskva. 488 s.
2. Baessler C., Klotz S. 2006. Effects of changes in agricultural land-use on landscape structure and arable weed vegetation over the last 50 years. *Agriculture, Ecosystems and Environment*. No. 115. P. 43–50.
3. Bogovin A. V., Dudnyk S. V. 2003. Ekolohichnyi analiz roslynnosti pryrodnykh bioheotsenoziv (fiziohnomichni ta florystyko-indyvidualistychni aspekty analizu v ekolohii). *Ekolohiia ta noosferolohiia*. T. 13(1–2). S. 4–11.
4. Bogovin A. V., Ptashnik M. M. 2006. Perspektyvna systema vyznachennia kormovoi tsin-

nosti travianystykh fitotsenoziv. *Kormy i kormovyrobnytstvo. Natsionalna akademiia ahrarnykh nauk Ukrainy.* Vyp. 56. S. 76–83.
5. Bogovin A. V. 2007. Specifics in formation of plant communities on arable lands removed from intensive treatment. *Grassland Ecology VII: Book of Proceedings.* Banska Bystria. P. 203–207.
6. Bondareva L. M. 2004. Populiatsii zlakiv, yak indykator ekolohichnoi stabilnosti luchnykh uhrupuvan. *Visnyk Sumskoho nats. ahrarn. un-tu. Seriia "Ahronomiia i biolohiia"*. No. 6(9). S. 148–151.
7. Bondareva L. M., Kyrylchuk K. S. 2012. Reproduktyvne zusyllia osnovnykh hospodarskykh hrup luchnykh roslyn na zaplavnykh lukakh pivnichnoho skhodu Ukrainy v umovakh paskvilnoho ta fenisytsialnoho navantazhennia. *Visnyk Sumskoho natsionalnoho ahrarnoho universytetu. Seriia "Ahronomiia i biolohiia"*. No. 9(24). S. 3–6.
8. Buisson E., Dutoit T., Torre F. 2006. The implications of seed rain and seed bank patterns for plant succession at the edges of abandoned fields in Mediterranean landscapes. *Agriculture, Ecosystems and Environment*. No. 115. P. 6–14.
9. Burda R. I. 1996. Do pytannia pro antropohennu transformatsiiu flory. *Ukr. Bot. Zhurn.* T. 53(1–2). S. 26–32.
10. Chaika V. M. 2003. Chynnyky fitosanitarnoho stanu. *Zakhyst roslyn*. No. 4. S. 1–3.
11. Cherniaev V. M. 1959. *Konspekt rastenyi dykorastushchykh y razvodymykh v okrestnostiakh Kharkova y v Ukrayne*. Kharkov. 90 s.
12. Dobrochaeva D. N. 1999. *Opredelytel vysshykh rastenyi Ukrayny*. Kyev: Fytosotsyotsentr. 548 s.
13. Dospekhov B. A. 1985. *Metodyka polevoho opyta (s osnovamy statystycheskoi obrabotky rezultatov yssledovanyi)*. Moskva: Ahropromyzdat. 351 s.
14. Klapp E. 1961. *Senokosy y pastbyshcha.* Moskva: Yzd-vo s.-kh. lyt., zhurn. y plakatov. 472 s.
15. Koroviakova T. O. 2011. Ontohenetychna ta vitalitetna struktura populiatsii luchnoho riznotravia na zaplavnykh lukakh r. Psel v umovakh pasovyshchnoi dyhresii. *Ukr. botan. zhurn*. T. 68. No. 5. S. 651–663.
16. Kostychev P. A. 1886. *Pochvy chernozemnoi oblasty Rossyy, ykh proyskhozhdenye, sostav y svoistva.* Sankt-Pyterburh. 239 s.
17. Lososova Z., Simonova D. 2008. Changes during the 20th century in species composition of synanthropic vegetation in Moravia (Czech Republic). *Preslia*. No. 80. P. 291–305.
18. Malynovska I. M., Bogovin A. V. 2009. Formuvannia biotychnykh system mikroorhanizmiv u grunti za riznykh sposobiv vidtvorennia roslynnykh uhrupuvan. *Zemlerobstvo.* Vyp. 81. S. 105–119.
19. Melnychuk O. S., Kovalivska H. M. 1972. *Atlas naibilsh poshyrenykh burianiv Ukrainy.* Kyiv: Urozhai. 204 s.
20. Pavlovych L. V. 1892. *Ocherky rastytelnosty Kharkovskoi hubernyy y prylezhashchykh k nei mestnostei.* Kharkov. 122 s.
21. Pashkevich N. 2011. Vegetation of abandoned fields in Ukraine. *Dry Grassland of Europe: Biodiversity, Classification, Conservation and Management: 8th European Dry Grassland Meeting*. P. 43.
22. Pashkevych N. A., Havrylov S. O. 2012. Transformatsiia roslynnoho pokryvu perelohiv Shatskoho natsionalnoho pryrodnoho parku. *Pryroda Zakhidnoho Polissia ta prylehlykh terytorii. Rozdil biolohiia.* No. 9. S. 139–142.
23. Protopopova V. V. 1991. *Synantropnaia flora Ukrayny y puty ee razvytyia*. Kyev: Naukova Dumka. 204 s.
24. Saiko V. F. 2000. *Vyluchennia z intensyvnoho obrobitku maloproduktyvnykh zemel ta yikhnie ratsionalne vykorystannia: Metodychni rekomendatsii.* Kyiv: Ahrarna nauka. 38 s.
25. Serebriakov Y. H. 1962. *Ekolohycheskaia morfolohyia rastenyi*. Kyev: Vysshaia shkola. 378 s.
26. Solomakha V. A., Balashov L. S. 1995. Metodyka vyznachennia kormovoi tsinnosti travostoiv sinokisno-pasovyshchnykh uhid. *Ukrainskyi botanichnyi zhurnal*. T. 52(1). S. 127–131.
27. Sukachev V. N. 1916. O teoryy dernovoho protsessa prof. V. R. Vyliamsa. *Pochvovedenye*. No. 2. S. 1–26.
28. Tyser L., Hamouz P., Novakova K. 2009. Changes in weed communities on selected areas with 30 years' interval. *Scientia Agriculturae Bohemica*. No. 40. P. 18–25.
29. Vereshchahyn L. N. 2002. *Atlas sornykh, lekarstvennykh i medonosnykh rastenyi.* Kyev: Yunyvest marketynh. 384 s.
30. Vysotskyi H. N. 1915. Erhenia: Kulturno-fytolohycheskyi ocherk. *Trudy po prykladnoi botanyke.* Vyp. 8. No. 10–11(84). S. 1113–1443.
31. Zlobyn Y. A. 2009. *Populiatsyonnaia ekolohyia rastenyi: sovremennoe sostoianye, tochky rosta.* Sumy: Unyversytetskaia knyha. 263 s.
32. Yakubenko B. Y. 2007. *Pryrodni kormovi uhiddia Lisostepu Ukrainy: flora, roslynnist, dynamika, optymizatsiia.* Avtoref. dys. na zdobuttia nauk. stupenia dok. nauk. Kyiv. 42 s.
33. Yhlovykov V. H. 1971. *Metodyka opytov na senokosakh y pastbyshchakh*. Moskva: Yzd. VYK. 231 s.

Žana Samčiuk

DIRVONUOJANČIŲ ŽEMIŲ BŪKLĖS AGROEKOLOGINIS VERTINIMAS UKRAINOS MAŽOJOJE POLESĖJE

S a n t r a u k a

Vykdant žemės reformą Ukrainoje 5–8,5 mln. ha ariamosios žemės ėmė dirvonuoti ir tapo netinkama naudoti. Tyrimo tikslas – įvertinti dirvonuojančių žemių augalijos ir dirvožeminės dangos agroekologinę būklę skirtingose suksesinių pokyčių stadijose natūraliomis mažosios Polesės sąlygomis. Atlikti tyrimai kontroliniuose plotuose sudarė sąlygas nustatyti augalijos rūšinę sudėtį, bioekologinę struktūrą, suksesinių pokyčių stadijas, pašarinę vertę ir bioproduktyvumą. Pagrindinės dirvožemių agrocheminės savybės įvertintos laboratoriniais tyrimais.

Raktažodžiai: humuso sudėtis, piktžolės, augalinės dangos produktyvumas