ISSN 2226-3063 e-ISSN 2227-9555
Modern Phytomorphology 15: 126–131, 2021

RESEARCH ARTICLE

Peculiarities of botanical composition formation of cereal agrophytocenosis on sod-podzolic soil depending on fertilization

U.M. Karbivska [1], A. O. Butenko [2*], V.F. Kaminskyi [3], N.M. Asanishvili [3], M.A. Tkachenko [3], V.H. Kurgak [3], H.I. Demydas [4], V.V. Moisiienko [5], I.T. Slyusar [3], M.I. Shtakal [3], E.H. Degodyuk [3], S.E. Degodyuk [3], H.M. Solovei [6]

[1] Vasyl Stefanyk Precarpathians National University, 57 Shevchenko Street, Ivano-Frankivsk, 7601841, Ukraine
[2] Sumy National Agrarian University, Gerasim Kondratyev Str. 160, 40021, Sumy, Ukraine; * andb201727@ukr.net
[3] National Scientific Centre "Institute of Agriculture of the National Academy of Agrarian Science of Ukraine", Mashynobudivnykiv Str. 2b, 08162, Chabany, Ukraine
[4] National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony Str. 15, 03041, Kyiv, Ukraine
[5] Polissia National University, 7 Staryi Blvd, Zhytomyr, 10008, Ukraine
[6] National Scientific Agricultural Library of NAAS, 03127, Kyiv, Ukraine

Received: 24.11.2021 | **Accepted:** 08.12.2021 | **Published:** 17.12.2021

Abstract

Despite the favorable climatic conditions of the region for onion growing, due to significant plowing of foothills (up to 80%) and low productivity, which does not exceed 1.3 t/ha-1.5 t/ha of fodder units, they do not fully perform their fodder production and environmental function. Ago Peculiarities of cereal agrophytocenosis formation when growing on sod-podzolic soil of Precarpathians depending on doses and NPK ratios of mineral fertilizers have been studied is relevant today. Perennial cereal grass was formed from Phléum praténse, Lolium pratense and Bromus inermis, which is kept in agrocenosis at sufficient level with a sprout density of 1440 pcs/m^2-2726 pcs/m^2, share of sown crops 64%-95% and linear growth in the first moving on nitrogen-free backgrounds 31 cm-100 cm. Fertilizers had a different effect on the density and transformation of a sown cereal grass, especially by the years of its usage. With the application of N25 grass height increases by 1.3, and N50 by 1.7 times. In the third year of usage, agrophytocenosis, which is formed from a mixture of cereal grasses, is transformed into a grouping with a predominance of Bromus inermis, the share of which increases with the nitrogen dose increase.

Keywords: Cereal grasses, mineral fertilizers, botanical composition, density of sprouts, sod-podzolic soil

Introduction

The creation of sown high-yielding grasslands with the usage of perennial grasses is one of the important directions in grass farming. On high agro-backgrounds, when following recommended regime of usage, they provide not only highly productive longevity of meadow cenoses, proper fodder quality but also thanks to a wide range of species and varieties allow organizing raw material conveyors on their basis. Such grasslands should be created during the application of complete mineral fertilizer with high nitrogen doses on all types of meadows (Kovtun and Veklenko 2006; Karbivska 2020; Hryhoriv et al. 2021). The study of phyto-diversity of meadow agrocenoses will make it possible to determine development rates of these agroecosystems, and comprehensive analysis of grass species composition will give an opportunity to determine the role of sown grasses in agrocenosis, the reasons for their loss from general composition and emergence of other unsown species (Mashchak et al. 2010; Tester and Langridge 2010; Tsyhanskyi et al. 2019).

Due to differences in biological and ecological properties, some species react differently to the application of fertilizers, which can form grasslands with made botanical composition. Separate application of only nitrogen or phosphorus fertilizers leads to replacement of highland cereals with *Festuca rubra, Agrostis capillaris* and other lowland grasses (Cherniaeva 1990; Shiferaw et

al. 2011; Karpenko et al. 2019; Litvinov et al. 2020).

In single-species *cenoses, Bromus inermis, Dactylis glomerata, Festuca rubra, Poa pratensis*, and *Lolium perenne* react well to nitrogen (Kurgak 2010; Kvitko et al. 2021). When using high doses of nitrogen ($N_{300-720}$) the grass first improves and then worsens (Kreil and Oenema 1990; Scherner et al. 2016).

Today, intensive technologies have been developed, the ones that significantly improve the productivity of natural fodder lands, by 3-4 times. They include obligatory measures such as application of fertilizers, creation of sown grasslands, selection of varieties, etc. The most effective measure in the forest-steppe zone is the application of mineral fertilizers, especially nitrogen. Under conditions of economic crisis and high cost of fertilizers, their application on meadow lands takes place much less than necessary, therefore the problem of increase of fertilizer application efficiency on haymaking and pasture meadows acquires special urgency (Paz-Ferreiro 2016; Kushchuk 2020; Karbivska et al. 2020; Demydas et al. 2021).

Much attention is paid to the improvement of meadow fertilization systems both in our country and abroad. Research of many scientists has developed and recommended to production scientific and practical fundamentals for improving efficient usage of natural fodder lands depending on ecological, zonal and biological conditions, in particular phytocenotic parameters of species and agrotechnical factors; determined basic principles of grass mixture selection for haymaking and pastural usage of lands and efficient systems of their fertilization (Makarenko et al. 2002; Litvinov et al. 2019; Tonkha et al. 2021).

Despite a significant amount of research on the doses of fertilizers for the botanical composition of cereals, until recently experimental data on the use of modern methods and modeling experiments with fertilizers on agrophytocenoses in the Carpathians of Ukraine is not enough. Therefore, these issues were the purpose of research, the results of which are presented in this article.

Materials and Methods

Experimental research was conducted on research field of Agrochemistry and Soil Science Department of Dendrological Park "Druzhba" at SHEI "Vasyl Stefanyk Precarpathian National University". The experiment was conducted on cereal grassland, which was formed based on grass mixture (Lolium pratense, 8 kg/ha + *Phléum praténse*, 6 kg/ha + Bromus inermis, 12 kg/ha), records and observations were conducted during 2017-2019.

The size of sowing areas is 15 m^2, accounting areas 10 m^2. The experiment was repeated four times. Phosphorus-potassium fertilizers were applied annually superficially in early spring, and nitrogen in three parts N_{25} and N_{150} in spring on froze-melting soil and after the first and second mowings. The following types of fertilizers were used in the experiment: nitrogen-ammonium nitrate (34%), potassium- potassium and magnesium sulphate (26%), phosphorus-simple superphosphate (18.7%).

The experiment scheme included the following variants:

Factor A: grass mixture-*Phléum praténse, Lolium pratense, Bromus inermis.*

Factor B: fertilizers-1. Control (without fertilizers); 2. P_{60}; 3. K_{90}; 4. $P_{60}K_{90}$, 5. N_{75}; 6. $N_{75}P_{60}K_{90}$; 7. N_{150}; 8. $N_{150}P_{60}K_{90}$.

Weather and climatic conditions during research years differed slightly from long-term average indices both by precipitation and values of average daily temperatures. Thus, average daily air temperature during the growing season of 2017 exceeded long-term average value (+15.3°C) by 0.8°C. In 2018, precipitation amount was insufficient, by 93.6 mm less than long-term average value, which negatively affected regrowth of grasses in aftermaths.

The study was conducted according to methodology of the Institute of Fodders and Agriculture of Podillya NAAS (Babych 1994). The balance of nitrogen, phosphorus and potassium in the soil was determined by the difference between the total amount of each element that entered the soil with fertilizers, precipitation and its alienation with the crop (Datko 2008).

Mathematical processing of research results was conducted by methods of disperse analysis and variation statistics according to Dospekhov (1985) on a personal computer using program Statistica 6.

Results and Discussion

Among the sown grasses, preservation of *Bromus inermis* in the grasslands was the best, and *Phléum praténse* was the worst. On average, during 2017-2019, the share of *Bromus inermis* was 38%-59%. Compared to nitrogen-free fertilizer backgrounds with the application of N_{150} on different phosphorus and potassium backgrounds, the share of nitrogen-free *Bromus inermis* increased by 9%-14%.

The content of *Phléum praténse* was at the level of 6%-7% and did not depend on fertilizer doses. The content of *Phléum praténse* was 22%-31% and it slightly decreased under the influence of nitrogen fertilizers. With nitrogen dose increase the total proportion of cereal grasses in the

harvest increased and the proportion of other different grasses decreased.

The botanical composition of sown cereal grass changed significantly over the years of usage (Fig. 1). Regardless of fertilizer variants, over the years the content of *Lolium pratense* decreased, and *Bromus inermis* and even other different grasses increased slightly.

Thus, *Lolium pratense* content decreased by 32%-35% from the first to the third year of usage. It was gradually replaced, first of all, by *Bromus inermis* and other different grasses. During this period, its amount increased by 26%-32% with application of nitrogen maximum dose, and it became dominant and the biomass turned almost into the one of *Bromus inermis*.

The content of different grasses during the period from the first till the third year increased from 5%-9% to 9%-12%. This index was slightly higher on the variants without nitrogen fertilizers.

Among different grasses, in the first three years of usage, one-year and biennial plants were mainly observed (*Galinsoga parviflora, Raphanus raphanistrum, Berteroa incana, Chenopodium album, Capsella bursa-pastoris, Erigeron canadensis, Lactuca serriola, Agrostemma githago, Galium aparine*), and somewhere perennial plants (*Taraxacum officinale, Convolvulus arvensis, Euphorbia virgata, Silene vulgaris, Plantago major*). Among non-sown cereal grasses, one-year *Echinochloa crus-galli* and perennial *Elymus repens* were found. It is known, that peculiarity of meadow cenosis formation and transformation are evaluated by the density of sprouts, the amount of which can vary between 1000 pcs/m^2-5000 pcs/m^2 (Epyfanov and Ivanova 1993).

Grass density depends to some extent on natural and climatic conditions. In the wet year and with nitrogen application more sprouts are formed in fall than in spring, in a dry year, on the contrary, in spring. Divided application of nitrogen by cycles of usage better balances the intensity of bushing and grass density during the spring-summer period compared to the application of the whole nitrogen dose in spring. This measure reduces the negative effect of summer grass depression in the third cycle (Kurhak and Voloshyn 2017; Tanchyk et al. 2021).

Fertilizers had a different effect on the density and transformation of sown cereal grassland, especially over the years of its usage. A total number of sprouts naturally changed little under the action of fertilizers. Their total number ranged from 1737 pcs/m^2-2278 pcs/m^2 of sprouts. Under the action of nitrogen fertilizers, the number of *Bromus inermis* sprouts significantly increased and the number of Lolium pratense sprouts decreased. On average for three years, the number of *Bromus inermis* sprouts

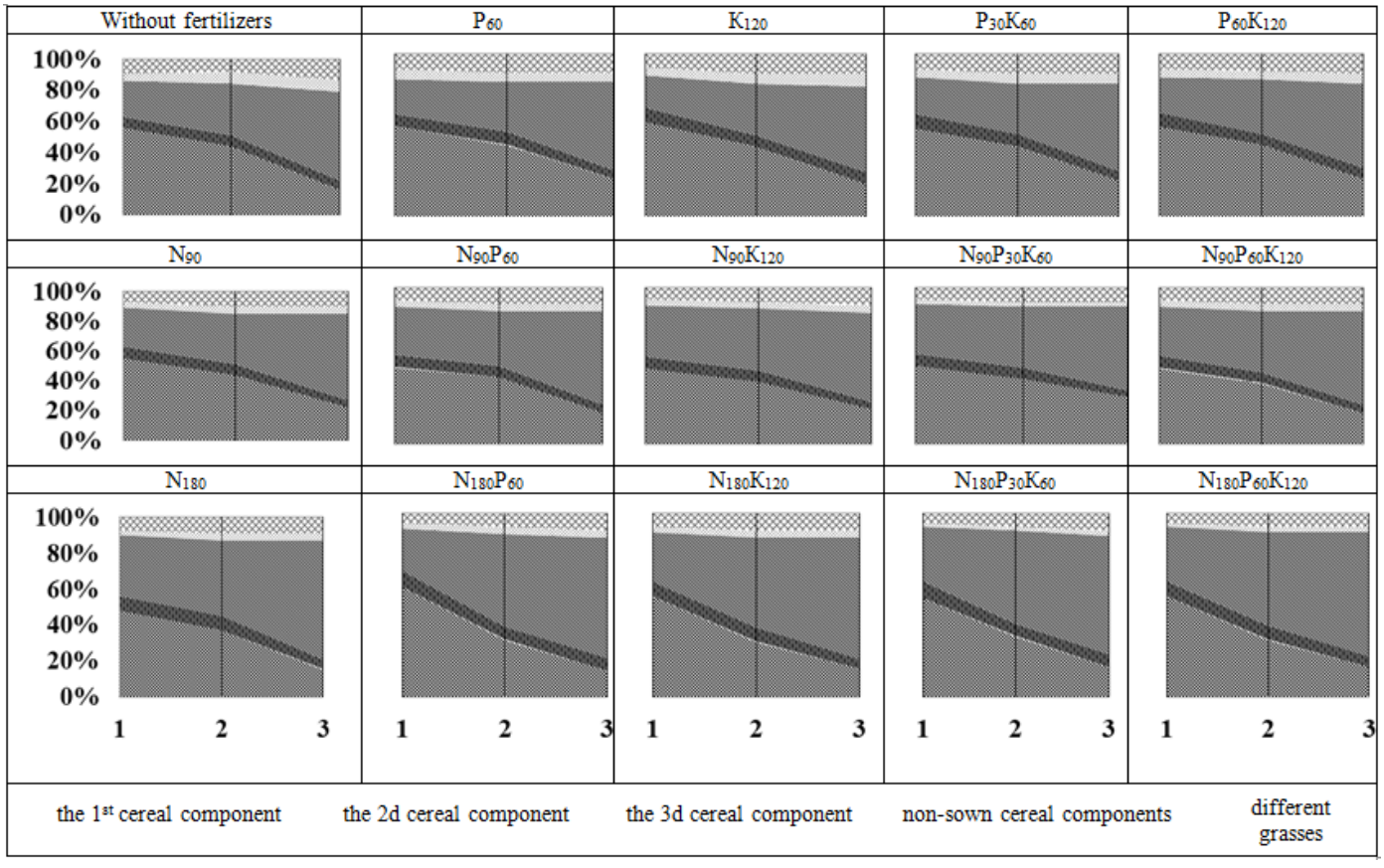

Figure 1. Influence of doses and NPK (Nitrogen, Phosphorus, Potassium) ratios of fertilizers on botanical composition of cereal grassland by the years of usage, average for 2017-2019.

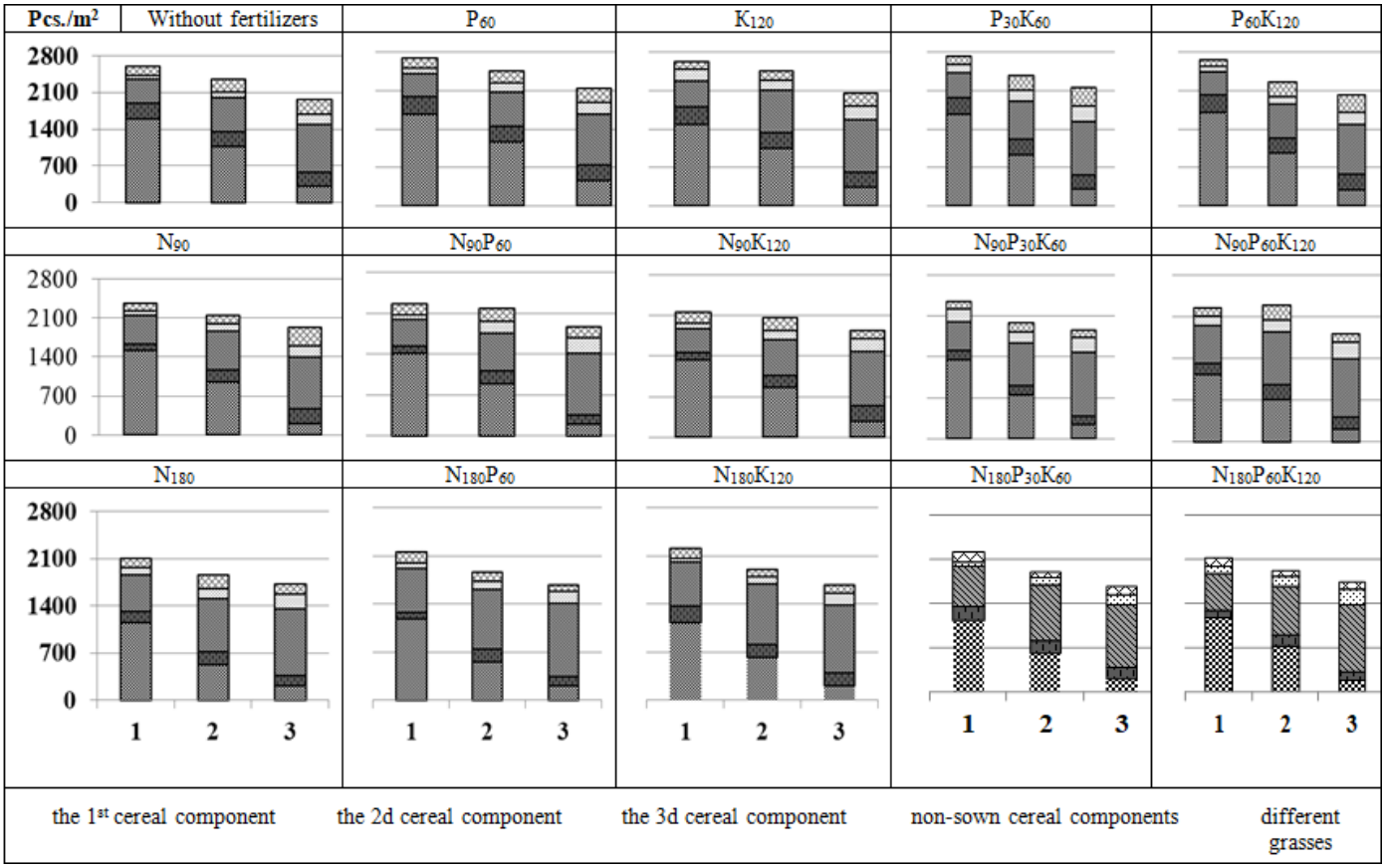

Figure 2. Influence of doses and NPK ratios of fertilizers on the density of cereal grass sprouts by years of usage, pcs/m².

ranged from 653 pcs/m²-863 pcs/m², with increasing doses of nitrogen fertilizers, the number increased.

In particular, in the variant with N_{150} in combination with phosphorus-potassium fertilizers, the number of sprouts increased by 91 pcs/m²-210 pcs/m² compared to nitrogen-free backgrounds The number of *Phléum praténse* sprouts ranged from 144 pcs/m² to 290 pcs/m² and did not depend much on fertilizer doses, and in the variant with *Lolium pratense* it ranged 702 pcs/m²-1105 pcs/m², under influence of nitrogen fertilizer dose of N_{150} it decreased by 358 pcs/m²-542 pcs/m².

The density of sown cereal grass changed under the influence of fertilizers also by the years of usage (Fig. 2). In particular, over time in a direction from the first to the third year of grassland usage, the total number of sprouts decreased from 2102-2726 to 1684 pcs/m²-2068 pcs/m², as well as the total number of cereals by 512 pcs/m²-748 pcs/m². Over the years, regardless of fertilizers, the number of sprouts of *Lolium pratense* and *Phléum praténse* decreased. Thus, the number of *Lolium pratense* sprouts decreased from 1132 pcs/m²-1703 pcs/m² to 187 pcs/m²-470 pcs/m² from the first to the third year of usage. Regardless of fertilization variants, the number of *Lolium pratense* sprouts decreased over the years, and the number of sprouts of *Bromus inermis* and to some extent different grasses and unsown (wild) cereals increased. *Lolium pratense* was replaced by *Bromus inermis*.

During the period from the first to the fourth year, the number of its sprouts increased from 412 pcs/m²-640 pcs/m² to 910 pcs/m²-1079 pcs/m². Its density was slightly higher in the variant of applying maximum nitrogen dose in all years. For the period from the first to the fourth year, the number of sprouts of unsown cereals increased from 59 pcs/m²-163 pcs/m² to 175 pcs/m²-288 pcs/m², and sprouts of different grasses from 124 pcs/m²-219 pcs/m² to 264 pcs/m²-340 pcs/m².

Thus, in the third year, the grassland which used to be *Lolium pratense* one in the first year of usage transformed into *Bromus inermis* grassland. This transformation was more significant on the background of nitrogen fertilizers. It was found that the height of cereal grassland components primarily depended on doses of nitrogen fertilization. With the application of N_{25} on average for years of research and by all three components in the first mowing, the height of grass increased from 56 cm-59 cm to 77 cm-80 cm, and with N_{50} by 1.7 times. All cereal grass mixtures reacted well to nitrogen application. With the application of N_{25} the height of *Bromus inermis* increased from 79 cm-82 cm to 105 cm-109 cm, and with the application of N_{50} the height of *Bromus inermis* increased to 126 cm-129 cm, the height of *Phléum praténse* increased from 43 cm-46 cm to 70 cm-73 cm, *Lolium pratense* from

47 cm-50 cm to 76 cm-79 cm.

Doses of phosphorus and potassium fertilizers had little effect on the linear growth of grasses. Among the sown species of grasses, *Bromus inermis* was the highest. Its average height was 105 cm. *Phléum praténse* was the lowest one (59 cm). *Lolium pratense* was intermediate in height (64 cm).

Conclusions

During three years, perennial cereal grasses, formed from *Phléum praténse, Lolium pratense and Bromus inermis* on sod-podzolic soil, kept in agrocenoses at sufficient level with sprout density of 1440 pcs/m^2-2766 pcs/m^2, the share of sown crops 64%-95% and linear growth on nitrogen-free backgrounds in the first mowing 31 cm-100 cm. *Bromus inermis* is characterized by the highest linear growth, and *Phléum praténse* by the lowest. With the application of N_{25} the height of grasses increases by 1.3 times, and N_{50} by 1.7 times. In the third year of usage, agrophytocenosis, which is formed from a mixture of cereal grasses, is transformed into a grouping with a predominance of *Bromus inermis*, the share of which increases with the nitrogen dose increase.

So, it is necessary to apply mineral fertilizers for cereal grasses, as mineral fertilizers increase cereal grass longevity and fertility of sod-podzolic soil. The results obtained in this study provide valuable information on the peculiarities of the formation of the botanical composition of cereal agrophytocenosis depending on the fertilizer. However, further research is needed to verify the results of the study and further improve the selection of mineral fertilizers and the composition of cereal grasses for growing on sod-podzolic soil. This should in the future help increase the productivity of cereal grasses.

References

Babych A.O. (1994). Methods of conducting experiments in fodder production and animal feeding. *Kyiv* 16-18.

Karbivska U. (2019). Crop yield and balance of main nutritional elements of dark gray soil for growing beans and grains. *Young Scientist* **10:** 392-397.

Butenko A., Litvinov D., Borys N., Litvinova O., Masyk I., Onychko V., Khomenko L., Terokhina N., Kharchenko S. (2020). The typicality of hydrothermal conditions of the forest steppe and their influence on the productivity of crops. *Environ Res Engineer Management* **76:** 84-95. https://doi.org/10.5755/j01.erem.76.3.25365

Shiferaw B., Prasanna B.M., Hellin J., Bänziger M. (2011). Crops that feed the world 6. Past successes and future challenges to the role played by maize in global food security. *Food Secur* **3:** 307-327. https://doi.org/10.1016/j.agee.2011.10.015

Scherner A., Melander B., Kudsk P. (2016). Vertical distribution and composition of weed seeds within the plough layer after eleven years of contrasting crop rotation and tillage schemes. *Soil Tillage Res* **161:** 135-142. https://doi.org/10.1016/j.still.2016.04.005

Tester M., Langridge P. (2010). Breeding technologies to increase crop production in a changing world. *Science* **327:** 818-822. https://doi.org/10.1126/science.1183700

Dospekhov B.A. (1985). Methodology of the field experience (with bases of statistical treatment of results of researches). 5th edition, 351. Agropromizdat, Moscow. http://vniioh.ru/dospexov-b-a-metodika-polevogo-opyta-5-e-izd

Didur I.M., Tsyhanskyi V.I., Tsyhanska O.I., Malynka L. V., Butenko A.O., Masik I.M., Klochkova T.I. (2019). Effect of the cultivation technology elements on the activation of plant microbe symbiosis and the nitrogen transformation processes in alfalfa agrocoenoses. *Modern Phytomorphol* **13:** 30-34. https://doi.org/10.5281/zenodo.20190107

Hryhoriv Ya.Ya., Butenko A.O., Kovalenko V.M., Zakharchenko E.A., Kriuchko L.V., Pshychenko O.I., Radchenko M.V., Trotska S.S., Terokhina N.O. (2021). Productivity of oat (Avena sativa L.) with different methods of cultivation on soddy-podzolic soils. *AMA* **51:** 1793-1799.

Paz-Ferreiro J., Fu S. (2016). Biological indices for soil quality evaluation: perspectives and limitations. Land Degradation Development **27:** 14-25. https://doi.org/10.1002/ldr.2262

Kurgak V.G. (2010). Meadow agrophytocenoses. *Kyiv DIA* 347.

Kvitko M., Getman N., Butenko A., Demydas G., Moisiienko V., Stotska S., Burko L., Onychko V. (2021). Factors of increasing alfalfa yield capacity under conditions of the Forest-Steppe. *J Agricult Sci* **1:** 59-66. https://doi.org/10.15159/jas.21.10

Tanchyk S., Litvinov D., Butenko A., Litvinova O., Pavlov O., Babenko A., Shpyrka N., Onychko V., Masyk I., Onychko T. (2021). Fixed nitrogen in agriculture and its role in agrocenoses. *Agron Res* **19:** 601-611. https://doi.org/10.15159/ar.21.086

Tonkha O., Butenko A., Bykova O., Kravchenko Y., Pikovska O., Kovalenko V., Evpak I., Masyk I., Zakharchenko E. (2021). Spatial heterogeneity of soil silicon in ukrainian phaozems and chernozems. *J Ecolog Engineer* **22:** 111-119. http://dx.doi.org/10.12911/22998993/130884

Demydas H.I., Galushko I.V., Butenko A.O., Karbivska U.M. & Asanishvili N.M. (2021). Fodder productivity of different meadow clover varieties depending on the elements of growing technology. *AMA* **51:** 1801-1811.

Karpenko O.Y., Rozhko V.M., Butenko A.O., Masyk I.M., Malynka L.V., Didur I.M., Vereshchahin I.V., Chyrva A.S., Berdin S.I. (2019). Post-harvest side rates impact on the weed littering of Maize. *Ukr J Ecol* **9:** 300-303.

Karbivska U., Kurgak V., Gamayunova V., Butenko A., Malynka L., Kovalenko I., Onychko V., Masyk I., Chyrva A., Zakharchenko E., Pshychenko., O. (2020). Productivity and quality of diverse ripe pasture grass fodder depends on the method of soil cultivation. *Acta Agrobotanica* **73:** 1-11.

Litvinov D.V., Butenko A.O., Onychko V.I., Onychko, T.O., Malynka L.V., Masyk I.M., Bondarieva L.M., Ihnatieva O.L. (2019). Parameters of biological circulation of phytomass and nutritional elements in crop rotations. *Ukr J Ecol* **9:** 92-98.

Makarenko P.S., Demydas H.I., Koziar O.M. (2002). Meadow farming. *Kyiv: Nora-Print* **394**.

Kushchuk M.A. (2020). Dynamics of botanical composition of alfalfa-cereal grass depending on doses and ratio of nrc and modes of use. *Scientific Research Center "Institute of Agriculture of NAAS"* **2:** 180-189.

Kovtun K.P., Veklenko Y.A. (2006). Influence of bacterial preparations on feed quality of legume-cereal grass mixtures. *Feed and Feed Production* **58:** 39-44.

Karbivska U.M. (2020). Influence of fertilizers on the botanical composition of various grasses in the conditions of Prykarpattia. *Agroecological J* **2:** 91-97. https://doi.org/10.33730/20774893.2.20-20.207686

Mashchak Ya.L., Smetana S.I., Liubchenko L.M., Liushniak M.V., Liushniak O.V. (2010). Botanical composition of herbage depending on tillage and fertilizer. *Peredhirne ta hirske zemlerobstvo i tvarynnytstvo* **52:** 70-78.

Kreil W., Oenema O. (1990). Grassland fertilization and environment. *Proc 13th General Meeting European Grassl Fed* **1:** 132-143.

Epifanov V.S, Ivanova E.N. (1993). Nitrogen fertilization of cereal grasses on the floodplain. *Agricult Chem* **7:** 17-19.

Kurhak V.H., Voloshyn V.M. (2017). Improving the efficiency of perennial legumes in the meadows of Ukraine. *Handbook of Ukrainian farmers «Biologization of agriculture »: scientific-practical collection* **1:** 288-291.

Chernyaeva I.I. (1990). Ecological problems of the use of nitrogen fertilizers. *Chem Village Farm* **4:** 20-24.