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BIOLOGICAL CO_2 CYCLE AND ORGANIC CARBON BALANCE IN MAIZE (*ZEA MAYS*) – SOYBEAN (*GLYCINE HISPIDA (MOENCH) MAXIM.*) AGROCENOSIS IN SOD-PODZOLIC SOIL

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Topicality. *Today, the search for ways to accumulate organic carbon and restore soil fertility, as well as increase crop yield, is a topical issue for the sod-podzolic soils of Western Polissia.* ***Purpose.*** *To determine the intensity of CO_2 emission and the organic carbon balance on sod-podzolic soil at different fertilizer rates in the maize-soybean link against the background of chemical amelioration with incorporation of by-products.* ***Methods.*** *We used such methods as a stationary field trial, comparative and calculation method to determine the accumulated and emitted CO_2 by plants, analytical and calculation methods to determine the organic carbon balance.* ***Results.*** *The CO_2 emissions from organic matter mineralization amounted to 5.01–5.45 t/ha by the fertilizer rate recommended and calculated by the normative method on the background of dolomite and lime meals, which was 23.4–34.2 % higher than the control (without fertilizers). The CO_2 emission into the atmosphere through plant mass mineralization, depending on fertilization and chemical melioration, was in the range of 18.6–24.7 t/ha and exceeded the control (without fertilizers) and the background of 1.0 H_h (hydrolytic acidity) $CaMg(CO_3)_2$ by 1.2–2.0 times, which is associated with improved soil conditions, higher by-products mass and CO_2 accumulation by plants. The highest amount of CO_2 was accumulated by maize (64.8–65.0 t/ha) and soybean (15.0–15.8 t/ha) at combination of the fertilizer rate calculated by the normative method with microfertilizers on the background of dolomite meal. The application of calculated fertilizer rates on the background of 1.0 Hh $CaMg(CO_3)_2$ provided an advantage in the formation of organic carbon in the soil, which formed a positive balance of 0.12 and 0.15 t/ha. In the variant without fertilizers and chemical amelioration, the ratio of total CO_2 emissions into the atmosphere per 1 t of grain yield in the maize-soybean link was 4.65 and 4.62 units, while the application of the fertilizer rate calculated by the normative method against the background of 1.0 Hh $CaMg(CO_3)_2$ decreased to 3.78 and 3.89 units, respectively.* ***Conclusions.*** *For increasing the maize and soybean productivity on sod-podzolic loamy sandy soil, incorporation of plant mass into the soil with applying the fertiliser rates calculated by the standard method against the background of 1.0 H_h $CaMg(CO_3)_2$ is an effective method to control soil degradation that ensures the inclusion of additional organic carbon into the cycle, which is aimed at its fixation by forming a deficit-free balance of 0.12 and 0.15 t/ha.*

Key words: *emission, organic carbon, productivity, fertilization, land amelioration, plant mass*

Introduction. In the context of global and regional climate change, an important source of greenhouse gases is the soil from which they enter the atmosphere, which is a powerful reserve for the accumulation and storage of organic carbon in the form of humus substances [1–3]. Soil respiration causes the loss of carbon, which is mainly concentrated in organic matter. The loss of carbon due to the irrational use of arable soils turns agroecosystems into a powerful source of greenhouse gas, i.e. carbon dioxide [4].

The conversion of natural ecosystems to agricultural use has reduced soil organic carbon levels, releasing 50 to 100 Gt of carbon into the atmosphere from the soil each year, and therefore minor disturbances to soil respiration on a global scale can lead to major changes in atmospheric CO_2 concentrations [5]. Disturbance of soil respiration results in changes of CO_2 content in the surface layers of the atmosphere. About 80–90 % of atmospheric carbon dioxide is of soil origin, and among the CO_2 fluxes ente-

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ring the atmosphere, emissions from the soil surface are one of the most powerful [6, 7].

The accumulation of organic matter in the soil can be increased through the introduction of scientifically based environmentally balanced crop rotations. Supply of organic matter from crop by-products and chemical amelioration of acidic soils is an important reserve for stabilising the humus content [8–10]. Carbon retention in the soil is most optimal when there are large volumes of aboveground biomass and roots decomposing in moist soil, where aeration is not limited [11]. According to opinion of scientists, the main reasons for humus losses due to anthropogenic management of soils is an increase in its biogenicity compared to natural cenosis, which results in changes in the water regime and increased humus mineralisation [12].

Plants play a key role in the dynamic process of organic carbon cycle in the soil. The organic materials are decomposed at a rate proportional to the amount of organic matter in the soil. The higher organic content of the soil results in a higher level of carbon reserves. Soils with high organic matter content always emit more carbon than poor soils. Unfertilised sandy soils emit an average of 2 kg/ha/year of CO_2, loams – 4 kg/ha/year, and medium-fertilised soils – 5 kg/ha/year [13]. The determining factor behind the significant imbalance of deposited carbon is tillage, unbalanced application of mineral fertilisers, and disruption of crop rotation, which negatively impact soil biota, reducing the environmental sustainability and productivity of agroecosystems [14–16].

Currently, the research on organic carbon management in the Polissia zone is insufficient; therefore, there is a need to develop practices for its sequestration in low-fertility soils. Carbon sequestration in the soil and CO_2 production depends on humus reserves, since humus contains 58 % of organic carbon on average [17]. Management of carbon sequestration processes is essential to overcome soil degradation The topicality of our research is related to finding ways to accumulate organic carbon in the soil, which will help reduce greenhouse gas emissions into the atmosphere, increase humus content and preserve the fertility of sod-podzolic soil. Therefore, the issue of the biological CO_2 cycle under the impact of fertilisers against the background of chemical amelioration and by-products in Western Polissia requires in-depth analysis.

Purpose. To investigate the carbon dioxide cycle in the maize-soybean link at different fertiliser rates against the background of chemical amelioration and incorporation of by-products, to determine the intensity of CO_2 emissions and the organic carbon balance of sod-podzolic soil.

Materials and Methods. The research was carried out in a stationary experiment in the maize – soybean link of crop rotation. The sown area of the plot is 99 m^2 (16.5x6), the accounting area is 50 m^2 (12.5x4), and the experiment was replicated three times. The experimental design is sequential. The crop cultivation technology is generally accepted for the Polissia zone.

Experimental design: 1. No fertilisers (control); 2. $CaMg(CO_3)_2$ (1.0 H_h) – background; 3. Background + NPK recommended + S_{40} + microfertiliser (2 treatments); 4. Background + NPK calculated by the normative method (according to the nutrient removal by the main product) + S_{40} + microfertiliser (2 treatments); 5. Background + NPK calculated by the normative method (according to the nutrient removal by the main and by-products) + S_{40} + microfertiliser (2 treatments); 6. Background + N calculated by the normative method (according to the nutrient removal by the main products) + S_{40} + microfertiliser (2 treatments); 7. $CaMg(CO_3)_2$ (1.5 H_h) + recommended NPK + S_{40} + micronutrient fertiliser (2 treatments); 8. $CaCO_3$ (1.0 H_h) + NPK recommended + S_{40} + microfertiliser (2 treatments). The introduction of crop by-products is the general background of the experiment. Mineral fertilisers for maize and soybean were applied in the form of ammonium nitrate, ammophos, and potassium chloride according to the experimental design in the recommended rates of NPK (Table 1).

Chemical ameliorants in the form of dolomite $CaMg(CO_3)_2$ meal and lime $CaCO_3$ meal were applied before the laying out of a stationary experiment at a rate based on the hydrolytic acidity (H_h) in each variant. Foliar feeding with microfertiliser Nutrivant Universal (2 kg/ha) was carried out twice in the first pair and 3–5 pairs of leaves stages for soybean, and in the 3–5 and 6–8 leaves stages for maize.

At the time of laying out the experiment,

Table 1. NPK rates according to experimental design

Variants	Application rate of NPK for crop, kg/ha		
	soybean	maize	average
Rate recommended	$N_{45}P_{60}K_{60}$	$N_{120}P_{90}K_{120}$	$N_{83}P_{75}K_{90}$
Rate calculated by normative method according to the nutrient removal by the main product	$N_{55}P_{20}K_{50}$	$N_{165}P_{30}K_{50}$	$N_{110}P_{25}K_{50}$
Rate calculated by normative method according to the nutrient removal by the main and by-products	$N_{65}P_{50}K_{75}$	$N_{200}P_{70}K_{150}$	$N_{133}P_{60}K_{113}$
N rate calculated by normative method according to the nutrient removal by the main product	N_{55}	N_{165}	N_{110}

the soil of the experimental plot was sod-podzolic, cohesive sandy, with an acid reaction of the soil solution pH_{KCl}, low content of easily hydrolysable nitrogen compounds (according to Kornfield) and mobile potassium, and high mobile phosphorus content (according to Kirsanov).

The organic carbon content in the soil was determined according to DSTU 4289:2004 "Methods for determination of organic matter". The balance of organic matter was calculated using standard indicators and coefficients according to the methodology of the National Scientific Center "Institute for Soil Science and Agrochemistry Research named after O.N. Sokolovsky".

Results and Discussion. The carbon cycle of agrocenosis is indicated by CO_2 reserves in the biomass of crops and the intensity of CO_2 emissions to the atmosphere from various sources. Comparison of CO_2 accumulated by plants and emitted to the atmosphere as a result of mineralisation of plant residues and soil organic matter at different fertiliser rates and liming allows us to identify the best ways to manage sod-podzolic soil and minimise unproductive losses of organic carbon.

The biological productivity of crops is determined by the CO_2 pool accumulated during the growing season. The highest amount of CO_2 was found in the experimental variants with the application of complete fertiliser: 55.90–65.30 t/ha for maize and 13.70–15.80 t/ha for soybean. The required CO_2 amount for plant life is supplied by various sources, with the main part of its natural emission being released from the soil surface (Table 2).

Table 2. CO_2 cycle for growing maize and soybean on sod-podzolic soil, (average for 2021–2022), t/ha

Variants	CO_2 accumulated by crops			CO_2 emissions from different sources, t/ha				
					CO_2 emission from:			
	maize	soybean	average	From the atmosphere	plant mass	organic matter	chemical ameliorants	Total
No fertilisers (control)	30.40	8.86	19.63	1.96	12.40	4.06	-	18.42
$CaMg(CO_3)_2$ (1.0 H_h) – background	39.90	10.90	25.40	2.54	15.70	4.61	2.25	25.47
Background + $N_{83}P_{75}K_{90}$	60.90	13.70	37.30	3.73	22.80	5.01	1.92	33.79
Background + $N_{110}P_{25}K_{50}$	64.80	15.00	39.90	3.99	24.20	5.01	1.60	35.07
Background + $N_{133}P_{60}K_{113}$	65.00	15.80	40.40	4.04	24.70	5.01	1.68	35.71
Background + N_{110}	48.30	11.70	30.00	3.00	18.60	4.61	1.68	28.08
$CaMg(CO_3)_2$ (1.5 H_h) + $N_{83}P_{75}K_{90}$	65.30	14.50	39.80	3.98	24.40	5.45	2.35	36.57
$CaCO_3$ (1.0 H_h) + $N_{83}P_{75}K_{90}$	55.90	14.40	35.20	3.52	21.60	5.23	1.78	32.44

According to scientific data, the volume of carbon dioxide in the atmosphere is quite stable, therefore the atmosphere is not the main source of carbon dioxide and cannot fully satisfy the plant needs for this resource. In fact, plants usually utilize about 10 % of the possible diffuse inflow of CO_2 of their total requirements from the atmosphere [18], which was 1.96–4.04 t/ha in the maize – soybean agrocenosis in the conditions of the Western Polissia.

CO_2 emission into the atmosphere through plant mineralisation, depending on fertilisation and chemical amelioration, ranged from 18.6–24.7 t/ha and was 1.2–2.0 times higher than the control (no fertilisers) and against the background of 1.0 H_h of $CaMg(CO_3)_2$, which is a result of CO_2 accumulation by a larger mass of by-products and plant residues under improved soil nutrition. Without fertilisation and chemical amelioration on acid soils, the CO_2 was slowly accumulated by the aboveground and root parts of maize and soybean plants in the amount of 19.63–25.40 t/ha, as a result, CO_2 losses due to emission with plant mass were the lowest. Different mineral fertiliser rates on the background of liming contributed to both an increase in CO_2 emission fluxes and carbon accumulation in the soil, due to a more intensive cycle of this element. It was found that, on average, the highest CO_2 accumulation was observed in maize and soybean biomass in the variant with $N_{133}P_{60}K_{113}$ on the background of 1.0 H_h $CaMg(CO_3)_2$, which, in turn, is a source of increased carbon dioxide emissions during the incorporation of non-commodity part of the crop yield into the soil.

Intensive use of soil in agricultural production upsets the balance of carbon emission and deposition processes and leads to increased mineralisation of organic matter. A significant part of the minor constituents contains compounds that are easily decomposed by soil microorganisms, and carbon is returned to the atmosphere in the form of carbon dioxide [19]. In the experiment, the content of mineralised organic carbon converted to CO_2 under different rates of mineral fertilisers against the background of chemical amelioration averaged 4.61–5.45 t/ha, while the indicator for the control (without fertilisers) was 4.06 t/ha. CO_2 emissions due to application of the recommended and calculated rates of fertilisers against a background of 1.0 H_h of $CaMg(CO_3)_2$ increased by 23.4 % compared to the control (no fertilisers). The application of the recommended fertiliser rate at 1.5 t/ha H_h of $CaMg(CO_3)_2$ resulted in an increase in CO_2 emissions by 34.2 % compared to the control and by 18.2 % compared to the background, which is related to the organic carbon content in the studied soil variants.

Lime materials used to neutralise the acidity of the soil solution affect the flux of greenhouse gases into the atmosphere. According to researchers, while carbonate soils with high pH act as CO_2 sinks, in acidic soils, ameliorants serve as a net source of CO_2 [20]. CO_2 emissions due to the liming process were calculated considering the type, rate of ameliorant and conversion factor of 0.48 for dolomite meal and 0.44 for lime meal [21]. Emitted CO_2 growth to 2.35 t/ha was achieved by the introduction of 1.5 H_h of $CaMg(CO_3)_2$ due to an increase in the amount of carbonates in the dolomite meal.

According to the obtained data, it was found that the total amount of CO_2 emitted into the atmosphere was 18.42–36.18 t/ha and depended on the fertiliser rates on the background of chemical amelioration, which increased the carbon dioxide deposition by 1.5–2 times compared to the control (without fertilisers). The photosynthetic CO_2 flux, on average for two crops, varied in the range of 25.40–40.40 t/ha depending on different fertiliser rates with the addition of sulphur and microfertilisers against the background of chemical amelioration with incorporation of by-products and exceeded its emission by 0.30–5.10 t/ha, due to the high assimilation potential for the realisation of plant bioproductivity.

Incorporation of the non-commodity part of the yield increases the CO_2 dissipation into the atmosphere. In the experiment, the CO_2 emitted by plant mass in the fertilised variants was 74.7–78.7 % in the total emissions, but these variants showed higher crop productivity compared to the control and background (Table 3). Under such conditions, non-productive CO_2 emissions decreased, which indicates the effective use of carbon dioxide over the growing season.

The ratio between total CO_2 emissions and the average yield of grain units in the maize-soybean link in terms of cumulative yield depended on the mineral fertiliser rates against

Table 3. Influence of fertilisation and land amelioration on crop productivity and CO_2 emissions in Western Polissia, (average for 2021–2022)

Variant	Productivity, grain unit, t/ha	General CO_2 emissions, t/ha	Ratio between CO_2 emissions and crop productivity
No fertilisers (control)	3.54	16.46	4.65:1
$CaMg(CO_3)_2$ (1.0 H_h) – background	4.88	22.56	4.62:1
Background + $N_{83}P_{75}K_{90}$	7.51	29.73	3.96:1
Background + $N_{110}P_{25}K_{50}$	8.15	30.81	3.78:1
Background + $N_{133}P_{60}K_{113}$	8.07	31.39	3.89:1
Background + N_{110}	5.76	24.89	4.32:1
$CaMg(CO_3)_2$ (1.5 H_h) + $N_{83}P_{75}K_{90}$	7.93	32.20	4.06:1
$CaCO_3$ (1.0 H_h) + $N_{83}P_{75}K_{90}$	6.89	28.61	4.15:1

the background of chemical amelioration with the incorporation of by-products and plant residues into the soil. Thus, the ratio between CO_2 emission and 1 tonne of grain units was 4.65 and 4.62 units in the variants without fertilisers and chemical amelioration, while the ratio decreased to 3.78 and 3.89 units, when the calculated rates of NPK were applied on the background of 1.0 H_h of $CaMg(CO_3)_2$.

Carbon is the main component of soil organic matter. Its conservation and restoration is essential for sustainable agriculture. When there are no traditional organic fertilisers available, the source of soil carbon sequestration is the non-marketable part of the crop and root residues of cultivated crops. It was found that the crop-root and surface residues have almost equal contribution to the accumulation of organic carbon in the soil (Fig. 1). Only in the variant (background + $N_{133}P_{60}K_{113}$ + S_{40} + microfertiliser) with the highest productivity of crops, on average for two years, CO_2 accumulation from by-products was noted at the level of 51.8 % of the total amount.

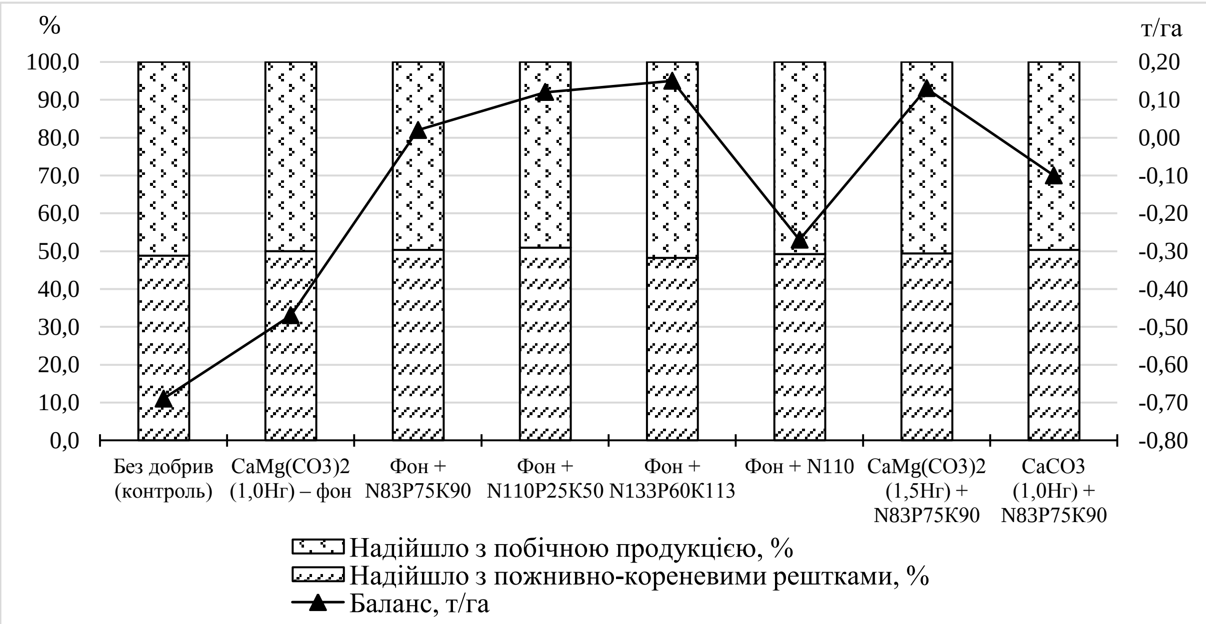

Fig. 1. The share of crop production in the organic carbon supply and its balance in the maize-soybean link, (average for 2021–2022)

In a stationary field trial, it was found that when there were no fertilisers in the control and in the variant of land amelioration with 1.0 H_h of $CaMg(CO_3)_2$ (background), the most deficient balance of organic carbon was formed on average over two years (0.47–0.69 t/ha). It should be noted that in the variants with unilateral application of nitrogen fertilisers N_{110} on the background of 1.0 H_h of $CaMg(CO_3)_2$ and $N_{83}P_{75}K_{90}$ (recommended rate) on the background of 1.0 H_h of $CaCO_3$, due to the increase in plant mass of maize and soybean by 16.0–33.4 %, the deficit balance of organic carbon decreases, but the balance remains negative (-0.27 and -0.10 t/ha, respectively). Only the application of mineral fertiliser rates calculated by the normative method at a background of 1.0 H_h and the recommended rates of $CaMg(CO_3)_2$ at a background of 1.5 H_h resulted in sufficient crop productivity, whereby the incorporation of crop-root residues and by-products formed an organic carbon balance of 0.12–0.15 t/ha.

Conclusions. Incorporation of plant mass into the soil to increase the maize and soybean productivity on sod-podzolic loamy sandy soil using the fertiliser rates calculated by the normative method against the background of 1.0 H_h of $CaMg(CO_3)_2$ is an effective method in the control of soil degradation, due to the inclusion of additional organic carbon in the cycle, which is aimed at its fixation by forming a deficit-free balance of 0.12 and 0.15 t/ha.

References

1. Bedernichek, T. Yu. (2017). Carbon reservoirs and fluxes in terrestrial ecosystems of Ukraine (according to the materials of scientific report at the meeting of the Presidium of NAS of Ukraine, November 9, 2016). *Visnyk NAAN Ukrainy* [Visnyk of the National Academy of Sciences of Ukraine], *1*. 98–106. https://doi.org/10.15407/visn2017.01.098. [in Ukrainian].
2. Lal, R. (2009). Sequestering Atmospheric Carbon Dioxide. *Critical Reviews in Plant Sciences*, *28 (3).* 90–96. https://doi.org/10.1080/07352680902782711.
3. Skrylnyk, Ie., Hetmanenko, V., Kutova, A., Moskalenko, V. (2021). Potential resources of organic raw materials in Ukraine and the approaches to their management for increasing soil organic carbon stocks. *Visnyk ahrarnoi nauky Prychornomoria* [Ukrainian Black Sea region agrarian science], *2 (110).* https://doi.org/10.31521/2313-092X/2021-2(110)-6. [in Ukrainian].
4. Ryzhuk, S., Kochyk, G., Melnychuk, A., Kucher, G., Savchuk, O. (2022). Justification of approaches and strategic directions for sequestration and increase of organic carbon in soils of Polissya zone. *Visnyk ahrarnoi nauky* [Bulletin of Agricultural Science], *5 (830).* 20–32. https://doi.org/10.31073/agrovisnyk202205-04. [in Ukrainian].
5. Food security and climate change: “4 per 1000” initiative new tangible global challenges for the soil (2019). *Conference report. Poitiers*, France 18–20 Jun 2019. https://simposium.inrae.fr/4p1000.
6. Baliuk, S., Kucher, A. (2019). Spatial features of the soil cover as the basis for sustainable soil management. *Ukrainskyi heohrafichnyi zhurnal* [Ukrainian Geographical Journal], *3 (107)*. 3–14. https://doi.org/10.15407/ugz2019.03.003. [in Ukrainian].
7. Kucher, A. (2015). *Ekoloho-ekonomichni aspekty rozvytku nyzkovuhletsevoho silskohospodarskoho zemlekorystuvannia* [Ecological and economic aspects of the development of low-carbon agricultural land use]. Kharkiv: Smuhasta typohrafiia, 68 p. [in Ukrainian].
8. Saskia, D., Keesstra, Johan Bouma et al. (2016). The significance of soils and soil science towards realization of the United Nations Sustainable Development Goals. [Soil], *2 (2).* 111–128. doi: 10.5194/soil-2-111-2016.
9. Karaieva, N., Bereznytska, M. (2014). Forming strategic direktions of the transition to low-carbon development in Ukraine based on peer review. *Ekonomichnyi visnyk Natsionalnoho tekhnichnoho universytetu Ukrainy «Kyivskyi politekhnichnyi instytut»* [Economic bulletin of National Technical University of Ukraine "Kyiv Polytechnical Institute"], *11*. 39–46. [in Ukrainian].
10. Kaminskyi, V. (2015). Crop rotation as the basis of sustainable land use and food security of Ukraine. *Zbirnyk naukovykh prats NNTs «Instytut zemlerobstva NAAN»* [Collection of scientific works of the National Scientific Center "Institute of Agriculture of the National Academy of Sciences"], *2*. 3–15. [in Ukrainian].
11. Polevoy, A., Bozhko, L. (2019). Assessment of organic carbon dynamics in podzolized chernozem soil in field crop rotation under the climate change. *Zhurnal Belorusskoho hosudarstvennoho universiteta. Geohrafiya. Geolohiya* [Journal of the Belarusian State University. Geography and Geology], *2*. 65–78. https://doi.org/10.33581/2521-6740-2019-2-65-78 [in Russian].
12. Tkachuk, V., Trofymenko, P. (2020). Humus content for different use of sod-podzolic sandy soil and the amount of CO_2 emissions lost. *Naukovi dopovidi NUBiP Ukrainy* [Scientific reports of National university of life and environmental sciences of Ukraine], *2 (84).* http://dx.doi.org/10.31548/dopovidi2020.02.007. [in Ukrainian]
13. Syabruk, O., Miroshnychenko, N., A. V. Dotsenko, A.. (2014). Influence of fertilization systems on CO_2 emissions from chernozem typical. *Pochvovedeniye i ahrokhimiya* [Soil Science and Agrochemistry], *1 (52).* 94–104. https://soil.belal.by/jour/article/download/443/443.
14. Gavryliuk, V., Melymuka, R. (2022). Carbon gas emissions and microbiological activity of soils under different agricultural purposes in conditions of Western Polissia. *Visnyk Sumskoho natsionalnoho ahrar-*

noho universytetu [Bulletin of Sumy National Agrarian University], *1*. 42–47. https://doi.org/10.32845/agrobio.2022.1.6. [in Ukrainian].
15. Trofymenko, P., Ivanik, O., Trofymenko, N. (2019). Methodology of CO_2 monitoring in the system "soil – atmosphere – plant" and daily biological circulation of soils carbon within Polissia zone Ukraine. *Tavriyskyi naukovyi visnyk* [Taurida Scientific Herald], *110 (2)*. 231–244. https://doi.org/10.32851/2226-0099.2019.110-2.30. [in Ukrainian].
16. Kohut, B., Semenov, V. (2020) Estimation of soil saturation with organic carbon. *Byulleten Pochvennoho instituta imeni V. V. Dokuchaeva* [Dokuchaev Soil Bulletin], *102*. 103–124. doi: 10.19047/0136-1694-2020-102-103-124 [in Russian].
17. Bedernichek, T. (2021). Vuhlets, grunt i parnykovi hazy. [Carbon, soil and greenhouse gases]. Chernivtsi: Druk Art. [in Ukrainian].
18. Nekos, V. Yu., Nekos, A. N., Safranov, T. A. (2010). Zahalna ekolohiia ta neoekolohiia: pidruchnyk [General ecology and neoecology: A textbook.]. Kharkiv, N. p. [in Ukrainian].
19. Halytska, M. A., Pysarenko, P. V., Kulyk, M. A. (2018). Humifikatsiшno-mineralizatsiшni protsesy yak pokaznyk akumulшatsii karbonu v gruntakh [Humification and mineralization processes as an indicator of carbon accumulation in soils.]. *Tavriyskyi naukovyi visnyk*: Silskohospodarski nauky [Taurida Scientific Herald: Agricultural sciences], *102*. 130-136. http://www.tnv-agro.ksauniv.ks.ua/archives/102_2018/22.pdf. [in Ukrainian].
20. Kunhikrishnan, A., Thangarajan, R., Bolan, N. S. et al. (2016). Chapter One – Functional Relationships of Soil Acidification, Liming, and Greenhouse Gas Flux. Ed.(s): Donald L. Sparks, *Advances in Agronomy, 139*. 1–71. https://doi.org/10.1016/bs.agron.2016.05.001.
21. *Measuring emission:* A guide for organizations: 2022 detailed guide (2022). Wellington, N. p. https://environment.govt.nz/publications/measuring-emissions-a-guide-for-organisations-2022-detailed-guide/.

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Актуальність досліджень пов'язана з необхідністю пошуку шляхів накопичення органічного вуглецю та відтворення родючості ґрунту, підвищення продуктивності культур на дерново-підзолистому ґрунті Західного Полісся. **Мета.** Дослідити цикл діоксиду вуглецю у ланці кукурудза – соя за різних доз удобрення на фоні хімічної меліорації та заорювання побічної продукції, встановити інтенсивність емісії CO_2 і баланс органічного вуглецю дерново-підзолистому ґрунту. **Матеріали і методи.** Стаціонарний польовий дослід, порівняльно-розрахунковий – для визначення акумульованого рослинами і емітованого CO_2, аналітичний та розрахунковий методи – для визначення балансу органічного вуглецю. **Результати.** Встановлено, що у разі внесення рекомендованої і розрахованої за нормативним методом дози добрив на фоні доломітового і вапнякового борошна емісія CO_2 від мінералізації органічної речовини становила 5,01–5,45 т/га, що вище за контроль (без добрив) на 23,4–34,2 %. Емісія CO_2 в атмосферу від мінералізації рослинної маси залежно від удобрення і хімічної меліорації знаходилась в межах 18,6–24,7 т/га і перевищувала в 1,2–2,0 рази контроль (без добрив) і фон $CaMg(CO_3)_2$ 1,0 $Н_г$, що пов'язано з покращеним режимом ґрунту, більшою масою побічної продукції і нагромадженням CO_2 рослинами. Найвища кількість CO_2 акумульована кукурудзою 64,8–65,0 т/га і соєю – 15,0–15,8 т/га за розрахункової дози добрив за нормативним методом сумісно з мікродобривами на фоні доломітового борошна. Застосування розрахункових доз добрив на фоні $CaMg(CO_3)_2$ 1,0 $Н_г$ під сільськогосподарські культури забезпечило перевагу утворення органічного вуглецю в ґрунті, що й формувало додатній баланс 0,12 і 0,15 т/га. У варіанті без добрив і хімічної меліорації на 1 т виходу зернових одиниць у ланці кукурудза-соя відношення загальної емісії CO_2 в атмосферу становило 4,65 і 4,62 од., тоді як за внесення розрахункової дози добрив за нормативним методом на фоні 1,0 $Н_г$ $CaMg(CO_3)_2$ відповідно знизилось до 3,78 і 3,89 од. **Висновки.** Заорювання рослинної маси в ґрунт за підвищення продуктивності кукурудзи і сої на дерново-підзолистому зв'язнопіщаному ґрунті із застосуванням розрахункових доз добрив нормативним методом на фоні 1,0 $Н_г$ $CaMg(CO_3)_2$ є ефективним заходом у боротьбі з деградацією ґрунту, оскільки забезпечує включення у колообіг додаткової кількості органічного вуглецю, який спрямований на його закріплення за рахунок формування бездефіцитного балансу 0,12 і 0,15 т/га.

Ключові слова: *емісія, органічний вуглець, продуктивність, удобрення, меліорація, рослинна маса*