GREENHOUSE GAS EMISSIONS FROM THE WINTER WHEAT AGROECOSYTEM IN CLIMATE CHANGE CONDITIONS

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The problem of global climate change is one of the most important issues in modern environmental science. Against the backdrop of discussions about the causes of climate change, a concept is being formed that modern climate change (e.g., temperature increase) is mainly caused by anthropogenic emissions of greenhouse gases, including carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) (IPCC, 2001). In this regard, an extremely important task is the assessment of greenhouse gas emissions from soil ecosystems .

As a theoretical basis for the quantitative assessment of CO_2 and N_2O emissions from the soils of the winter wheat agroecosystem during its spring-summer vegetation period, we used a comprehensive model of greenhouse gas emissions from agroecosystem soils (Polyovyi A.M., Bozhko L.Yu., 2021). Let us consider the results of modeling CO_2 emissions from agroecosystem soils during the spring-summer vegetation period of winter wheat in the main agroclimatic zones of Ukraine under climate change conditions. (Fig. 1).

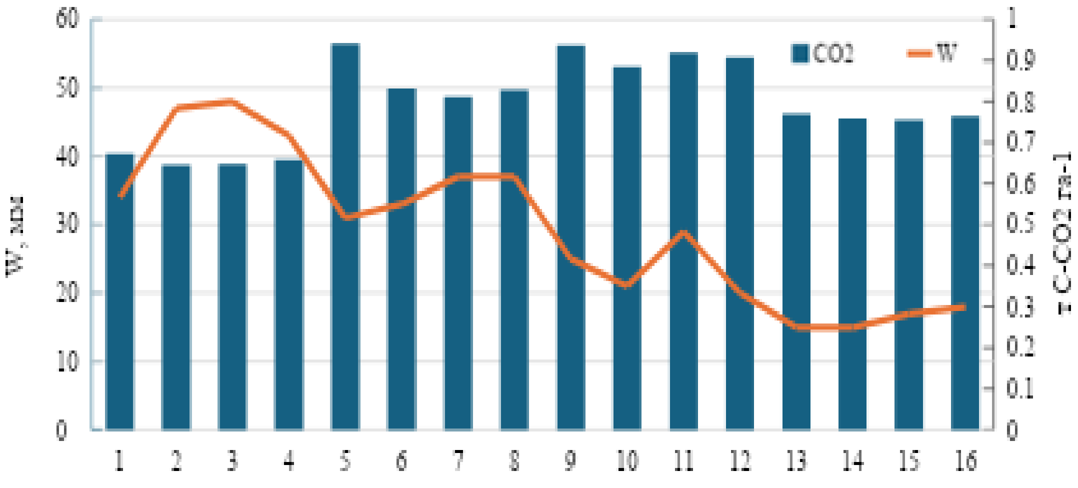

Fig. 1. Dynamics of CO_2 emissions from the winter wheat agroecosystem and productive moisture reserves in the arable soil layer (W).

The highest CO_2 emissions (0.886–0.940 t C-CO_2 ha^{-1}) are expected when the average productive moisture reserves in the arable soil layer during the spring-summer growing season of winter wheat range from 20 to 40 mm, with air temperatures of 12–15°C. Exceeding the average moisture reserves of 40 mm and air temperatures of 11–12°C leads to a decrease in CO_2 emissions (0.645–0.658 t C-CO_2 ha^{-1}). Under drought conditions, when the average moisture reserves in the arable soil layer drop below 20 mm and the average air temperatures during the spring-summer growing season of winter wheat rise to 14.5–15.2°C.

The process of N_2O emissions is primarily driven by denitrification and nitrification of nitrogen compounds, whose intensity is determined by the soil moisture-temperature regime and the content of mineral nitrogen in the soil. The results of modeling these processes are presented in Fig. 2 for the main agro-climatic zones of Ukraine.

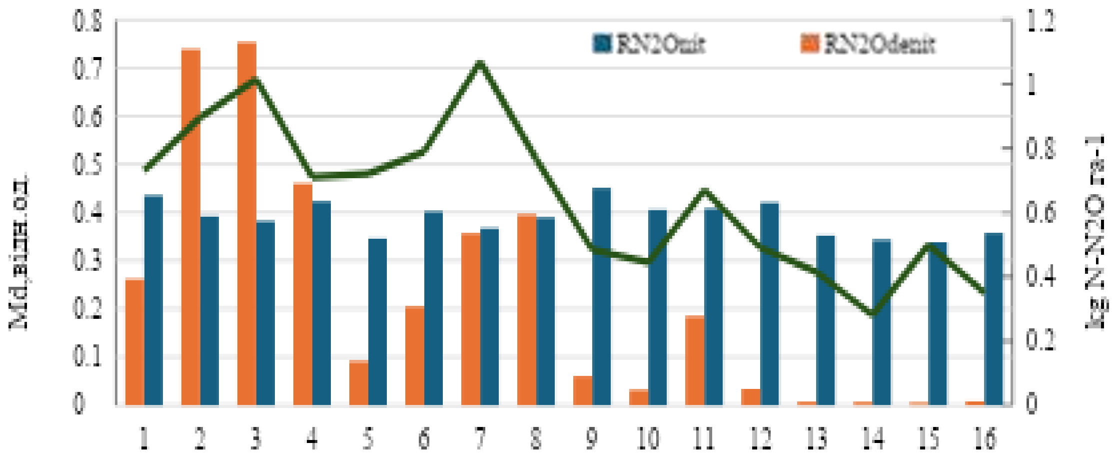

Fig. 2. Dynamics of N_2O emission owing to nitrification (RN2Onit) and denitrification (RN2Odenit) from the winter wheat agroecosystem and Shashko moistening indicator Md.

A small N_2O emission (1,089–1,703 kg N-N_2O ha^{-1}) during the spring-summer growing season of winter wheat is expected under high moisture levels (Md = 0,474–0,713 relative units) and air temperatures of 11,3–13,0°C. Moderate N_2O emissions (0,706–0,890 kg N-N2O ha^{-1}) occur under moisture levels of Md = 0,298–0,447 relative units and air temperatures of 13,4–14,7°C. In these conditions, denitrification processes slow down, while the contribution of nitrification to total N_2O emissions increases. The lowest N_2O emissions (0,508–0,537 kg N-N_2O ha^{-1}) are expected under severe and extreme drought conditions (based on Md criteria), with elevated average air temperatures of 14,5–15,2°C during the spring-summer growing season of winter wheat.