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Opinion

The Influence of Climate Change on the Productivity of Winter Wheat in the Ukrainian Woodlands (Polissya)

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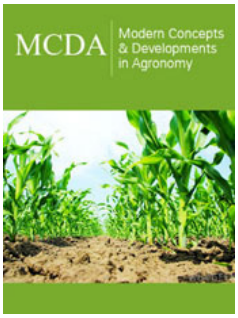

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Opinion

Global climate change leads to significant shift in agro-climatic conditions for growing crops, which cause fluctuating in photosynthetic productivity of plants.

Analysis of the climate change trend influence on the formation of yields of the leading agricultural crop of Ukraine-winter wheat-was performed by comparing data from climate scenarios RCP4.5 and RCP8.5 and average long-term characteristics of climatic and agroclimatic indicators of 1986-2015 for Polissya.

As the main climatic and agroclimatic characteristics of the temperature regime were used: dates of stable transition of air temperature through 0, 5, 10, 15 °C in spring and autumn; duration of the periods with air temperatures above 0, 5, 10, 15 °C; the sum of positive air temperatures for the periods with temperatures above 0, 5, 10, 15 °C; average air temperature in January, July and their amplitude.

In Polissya, in case of implementation of the RCP4.5 scenario, there will be insignificant changes in temperature indicators. Thus, the date of transition of air temperature through 0 °C in spring will coincide with the average for the base period, and in autumn it will be observed a week earlier. The duration of the period will be reduced by three days. The average air temperature in January will rise slightly, and in July will drop to 18.6 °C. This will reduce the amplitude of the air to 21.3 °C, as well as reduce the sum of temperatures for the period to 2900 °C, which is less than the sum of the base period by 180 °C.

In the case of a high-emission scenario (RSP8.5), changes in air temperature will have slightly different dynamics over the same period. Thus, the transition of air temperature through 0 °C in spring and autumn will be observed 8 and 6 days earlier, respectively, than in the base period. The average air temperature in January will be -4.1 °C, and in July -18.8 °C, as a result of which the sum of temperatures for the period will be lower than the average for the base period by 80-90 °C.

In general, for the year on the territory of Ukraine, both in the base period and in the estimated forecast period of 2021-2050, according to different scenarios of climate change, a decrease in precipitation is expected. In Polissya, winter and spring amount of precipitation is expected to increase in both climate change scenarios. Moreover, in winter this increase will be insignificant and will be 107-108% compared to the base period. In spring, the increase in precipitation will be more significant and will amount to 131-132% of the long-term

average for this period. In summer, both climate change scenarios are expected to have the same sharp decrease in precipitation to 156mm, which will be 62% of the amount of precipitation in the base period. The same can be said for the autumn period, when precipitation in both scenarios are expected to be around 130mm, which will be 82% of the base amount.

The analysis is based on the agro-climatic model of crop formation [1], which is grounded on the principle of maximum plant productivity, formulated by Tooming [2]. The concepts of agroecological levels of productivity have been used: potential yield (PY)-a crop that is due to the arrival of photosynthetically active radiation (PAR) and biological characteristics of the culture; meteorologically possible harvest (MPH) - is a PY that is limited by the influence of humidity and temperature; really possible yield (RPY) is the MPH, which is limited by the level of natural soil fertility.

The average long-term air temperature during the spring-summer vegetation period of winter wheat was 8.7 °C. According to the RCP4.5 climate scenario is expected to reduce the average air temperature to 7.9 °C and by the RCP8.5 scenario to 8.1 °C. During the period of "vegetation restoration-the full maturity" of winter wheat, the average long-term precipitation was 221mm. According to the climate scenarios RCP4.5 and RCP8.5, the amount of precipitation is expected to increase to 233-246mm and, accordingly, to improve the moisture supply. The levels of agro-ecological yields, photosynthetic potential and the total yield will change accordingly (Table 1).

Table 1: Comparison of indicators of photosynthetic activity of winter wheat crops according to average long-term conditions and scenarios of climate change in Polissya.

Period, Year	Total Mass of the Crop, c ha^{-1}			Photosynthetic Potential, m^2 m^{-2} for the Period	Winter Wheat Harvest at a Grain Moisture Content of 14%, c ha^{-1}
	Potential Yield	Meteorologically Possible Harvest	Really Possible Yield		
Average long-term conditions					
1986-2015	315	243	127	216	44,5
RCP4.5 scenario					
2021-2050	343	263	132	239	46,3
RCP8.5 scenario					
2021-2050	344	266	133	244	47,1

As can be seen from the Table 1, the potential yield under scenario conditions will be 9% higher than under average long-term conditions. As for the meteorologically possible harvest, it will be 108-109% of the long-term average. Under the scenario conditions the photosynthetic potential will increase. It will be 111-113% of the long-term average. Accordingly, the grain yield of winter wheat will increase by 1.8–2.6c/ha when the scenarios RCP4.5 and RCP8.5 of climate change are implemented.

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