The Effect of High Temperatures on the Growth and Development of Winter Wheat Varieties (Case Study: Khorezm Region)

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Abstract: This article provides information on the effect of high temperatures on the growth and development processes of winter wheat varieties (Zimnitsa, Asr, Gurt) under the meadow-alluvial soil conditions of the Khorezm region.

Keywords: winter wheat, variety, Zimnitsa, Asr, Gurt, ecological factor, global warming, high temperature, meadow soils.

Introduction. Winter wheat is one of the primary cereal crops in agriculture, and its yield and quality indicators are significantly influenced by ecological factors. Climatic conditions, soil fertility, irrigation regime, and agronomic practices directly impact the growth and development processes of winter wheat. Factors such as high temperatures, soil salinization, and moisture deficiency are considered limiting factors for winter wheat cultivation in various regions worldwide.

In recent years, global warming has been observed to have adverse effects on crops, particularly winter wheat yield, in Uzbekistan, including the Khorezm region. Notably, during the spring vegetative period of winter wheat, when grains are forming temperatures exceeding 43–44°C hinder the full formation of grains and result in empty grains in the spikelets, ultimately reducing yields.

Addressing these challenges and conducting scientific research in this area hold significant practical importance. This article discusses the role of high temperature, a key ecological factor, in influencing winter wheat.

The impact of high temperatures on cereal crops has been studied by both international and Uzbek researchers. Scientists from the International Maize and Wheat Improvement Center consider the optimal air temperature for wheat growth and development to be between +18°C and +25°C [3]

However, the temperature requirements of winter wheat vary across different developmental phases. For instance, optimal temperatures are: +17.2°C for root growth, +18.5°C for stem growth and development, +16°C for spike formation, +23°C for pollination, and +26°C during the grain filling stage[2].

An increase in temperature negatively affects processes such as root and stem development, dry matter production, fertilization and pollination, and grain formation.

Materials and Methods. In this study, the research objects were the winter wheat varieties Zimnitsa, Asr, and Gurt. Biometric indicators for different variants were determined following the methodology described in the "Field Experiment Techniques" (UzPITI, 2007) [4].

Soil salinity was measured using the electrical conductivity of a 1:1 soil-water suspension, which was then multiplied by a coefficient of 3.5 to determine the salinity level. The resulting data were classified according to the standards established by FAO.

The mathematical and statistical analysis of the collected data was conducted using the ANOVA software.

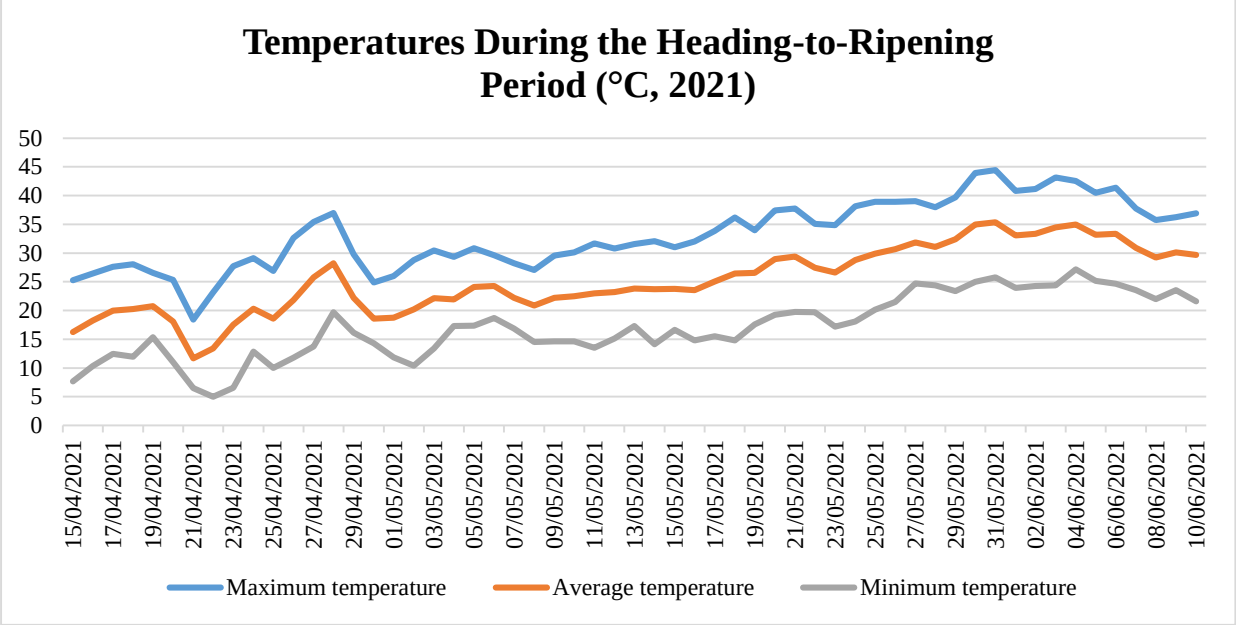
Research Results. The effects of global climate change on the growth, development, and yield of winter wheat were studied and analyzed under the conditions of the Khorezm region.

The research was conducted at the experimental farm of Urgench State University. Seeds of the winter wheat varieties Zimnitsa, Asr, and Gurt were sown on three different dates: October 1, October 10 and October 20, 2021.

The tillering phase of winter wheat during the spring vegetation period occurs in March, a time when high temperatures are not observed. However, in the climatic conditions of Uzbekistan, including the Khorezm region, the negative impact of high temperatures is noticeable during the heading, flowering, and ripening stages (milk, dough, and full ripening phases) of the spring vegetation period.

Consequently, the temperature conditions during the spring vegetation stages of winter wheat were investigated in this study, and their impact on plant development was determined (Figure 1).

Figure 1



The heading and flowering stages of winter wheat occurred in April during the 2020-2021 seasons, with an average temperature of +17 °C and a maximum temperature of +36.9 ° C. In May, the average air temperature rose to +26°C, with a maximum temperature of +44.4 ° C. Such sharp increases in temperature caused morphological and physiological changes in winter wheat.

High temperatures significantly accelerated the growth and development processes of winter wheat during the vegetation period, leading to the following negative consequences:

Leaf Senescence: High temperatures accelerated the leaf aging process, reducing the green surface area of the leaves and leading to a decrease in leaf coverage.

Impact on Photosynthesis: High temperatures reduce the efficiency of the photosynthesis process, slowing down the formation of dry biomass in plants.

Shortening of Flowering and Grain Filling Stages: Under high-temperature conditions, the flowering and grain formation stages do not proceed normally. As a result, the necessary time for proper grain formation is insufficient.

Reduction of Vegetative Period: Heat stress shortens the overall developmental cycle of the plant, leading to a decrease in yield.

Conclusion. Under the conditions of global climate change, high temperatures pose a serious threat to the growth and development of winter wheat. Adjusting sowing times to align with climatic conditions can help mitigate the negative impacts of high temperatures.

In the conditions of the Khorezm region, the sharply continental climate, combined with the impacts of global warming, leads to temperatures exceeding +45 ° C. This results in a reduction in leaf area, a decrease in net photosynthesis productivity and adverse effects on grain formation, causing an overall yield reduction of 7–8 quintals per hectare.

Implementing optimal agronomic practices, efficiently utilizing water and nutrient resources, and minimizing ecological risks play a critical role in improving wheat yields.

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