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STUDY ON MEETING THE WATER REQUIREMENTS OF MAIZE (*ZEA MAYS* L.) IN SOCOL, CARAȘ-SEVERIN COUNTY

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Abstract. *The present paper aims to analyze the climatic factors influencing the water requirements of maize (Zea mays L.) in the locality of Socol, Caraș-Severin County, during the years 2022–2024. The study builds on previous research concerning the impact of climatic variability on crop water balance, contributing new data for the western region of Romania. Climatic parameters, including monthly and annual temperature and precipitation regimes, were analyzed based on records from the Moldova Veche Meteorological Station. The Thornthwaite and Lawry–Johnson indirect methods were used to estimate maize water consumption, complemented by hydroclimatic balance calculations for the three study years. The results showed that 2024 was the driest and hottest year, with a total maize water consumption of 5685 m³/ha, while 2023 was the warmest and rainiest year, with the lowest consumption (4991 m³/ha). Rainfall covered 68% of maize water demand in 2022, 100% in 2023, and only 52% in 2024. These findings confirm the strong dependence of maize water balance on climatic variability and highlight the need for supplementary irrigation in years with reduced rainfall. It is recommended that irrigation compensate approximately 25–30% of the crop's water needs, using either sprinkler or drip systems. The originality of the study lies in its three-year comparative approach under local climatic conditions, offering practical implications for optimizing irrigation strategies and ensuring sustainable maize production in increasingly dry regions of Romania.*

Keywords*: maize, water consumption, Thornthwaite method, Lawry–Johnson method, hydroclimatic balance, irrigation management, Caraș-Severin*

INTRODUCTION

Maize (*Zea mays* L.) represents one of the most important cereal crops in the world, ranking third after wheat and rice, and second in terms of total cultivated area. Historical evidence indicates that this species has been cultivated on the American continent since ancient times.

In Europe, maize was introduced from the New World following Christopher Columbus's first expedition in 1493. For a long period, it was cultivated under the name "Indian wheat." It was first introduced into cultivation in Spain, from where it gradually spread to the rest of the European countries.

It is well known that the United States of America is the world's largest maize producer, a position it has shared or alternated in recent years with China. Europe also includes several major maize-producing countries, both members and non-members of the European Union, such as Ukraine. However, the total production achieved on the European continent is influenced by multiple factors, including the cultivated area, climate, relief, and crop technology.

Although maize shows good resistance to water stress, its requirements for the vegetation factor "water" remain high. It has a relatively low specific water consumption, ranging between 230 and 440. Maximum water consumption is recorded between June 10–20 and August 10–20, that is, from the stage preceding panicle emergence to the milk stage, when water use accounts for 68–74% of the total required during the entire growing season. During

this period, soil moisture should be maintained at 60–80% of field capacity, with daily water consumption estimated at 9–10 mm/ha.

Periods of extreme heat combined with pedological and atmospheric drought are particularly harmful to maize, leading to significant yield reductions and the formation of ears with missing kernels or incomplete rows.

MATERIALS AND METHODS

In the present study, the climatic elements of the analyzed years (2022, 2023, and 2024) were examined, namely: the monthly and annual thermal regime and its evolution during the analyzed period; the pluviometric regime, including precipitation patterns recorded during the vegetation period at the Moldova Veche Meteorological Station, Caraș-Severin County; as well as their evolution and deviations from the multiannual averages.

To estimate the water consumption of the maize crop, the following indirect calculation methods were applied: the Thornthwaite method and the Lawry–Johnson method. In addition, hydroclimatic balances were developed for the studied area for each of the three years under analysis.

Both the monthly and total water consumption of maize were determined for the experimental years 2022, 2023, and 2024, in the locality of Socol, Caraș-Severin County, using these indirect estimation methods.

RESULTS AND DISCUSSIONS

The year 2022 was characterized by lower temperatures in January, April, and September, while in all other months the recorded temperatures were higher than the multiannual average of the studied area, namely Socol, Caraș-Severin County.

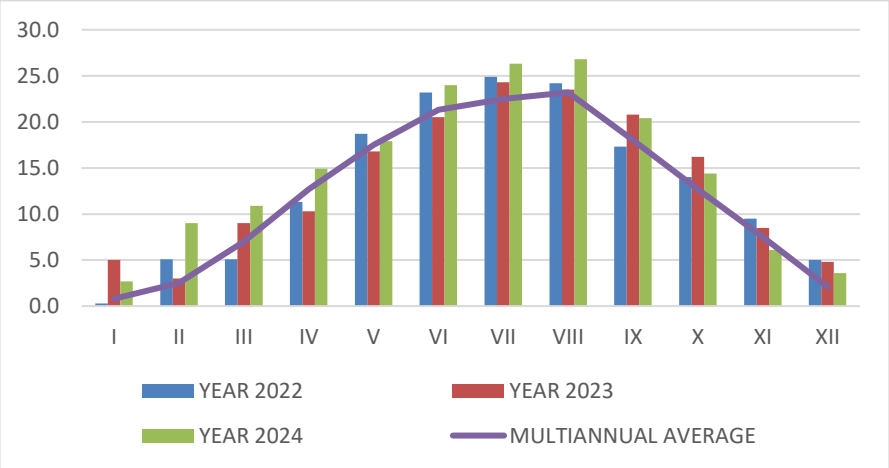

Figure 1. Variation of monthly mean air temperatures (°C) compared to the multiannual average (°C) in Socol, Caraș-Severin County, for the years 2022–2024.

Among the three analyzed years, 2024 was the warmest, both during the vegetation period and throughout the entire year, compared to the multiannual average temperatures, followed by 2022 and 2023.

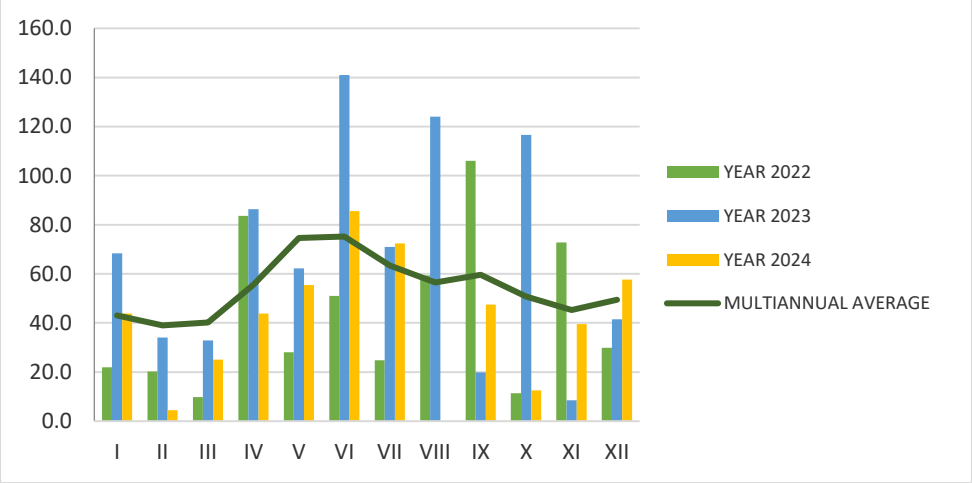

Figure 2. Variation of monthly precipitation (mm) compared to the multiannual average (mm) in Socol, Caraș-Severin County, for the years 2022–2024.

In 2022, only the months of August, September, and November recorded higher precipitation amounts than the multiannual average, while in the other months rainfall was below the normal values for the area.

As shown in Figure 2, the driest year was 2024, when total precipitation amounted to only 487.9 mm, compared to the multiannual average of 652.8 mm.

Hydroclimatic balance

From the analysis of the hydroclimatic balance graphs for Socol, Caraș-Severin County, over the three years, the monthly evolution of precipitation and potential evapotranspiration (ETP) can be observed, as well as the periods of moisture deficit, their magnitude, and duration. The moisture deficit occurs when the potential evapotranspiration exceeds the monthly precipitation values.

The analysis of the three graphs revealed that 2023 was the year with the smallest moisture deficit, compared to 2022 and 2024, while 2024 showed the greatest hydric deficit.

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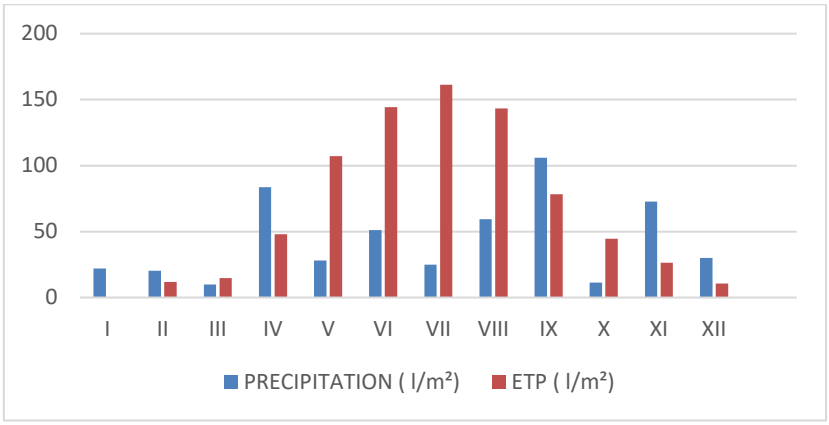

Figure 3. Hydroclimatic balance in 2022: Precipitation and Potential Evapotranspiration (ETP)

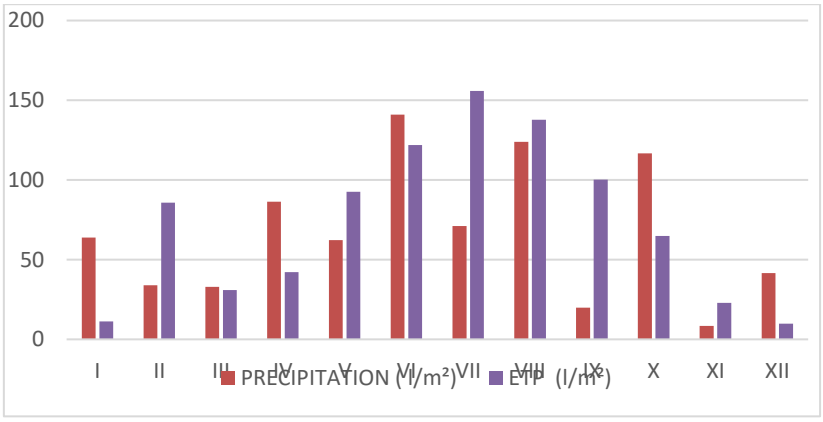

Figure 4. Hydroclimatic balance in 2023: Precipitation and Potential Evapotranspiration (ETP)

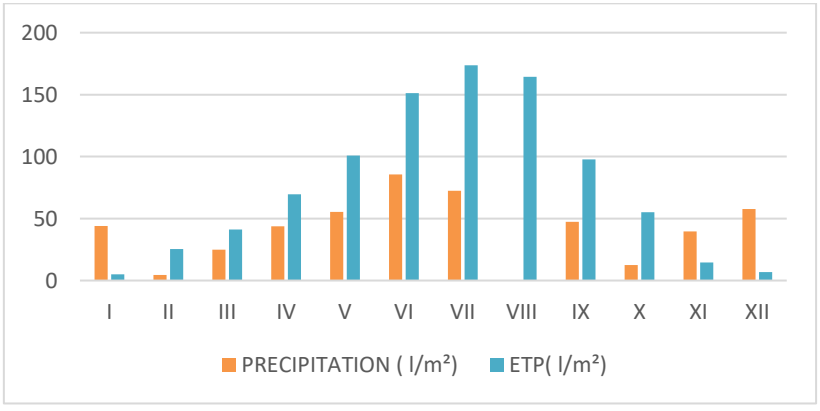

Figure 5. Hydroclimatic balance in 2024: Precipitation and Potential Evapotranspiration (ETP)

Coverage of maize water consumption from precipitation

Based on the calculations performed using the two indirect estimation methods — the Thornthwaite method and the Lawry–Johnson method — for maize grown under the climatic conditions of Socol, Caraș-Severin County, during the years 2022, 2023, and 2024, an analysis was carried out regarding the extent to which rainfall covered the monthly and total water requirements of the maize crop.

Although it was not specifically determined in this study, it should be noted that part of the crop's water demand is also covered by soil water reserves.

The total water consumption of the maize crop in Socol, Caraș-Severin County, was estimated at 5177 m³/ha in 2022, 4991 m³/ha in 2023, and 5685 m³/ha in 2024.

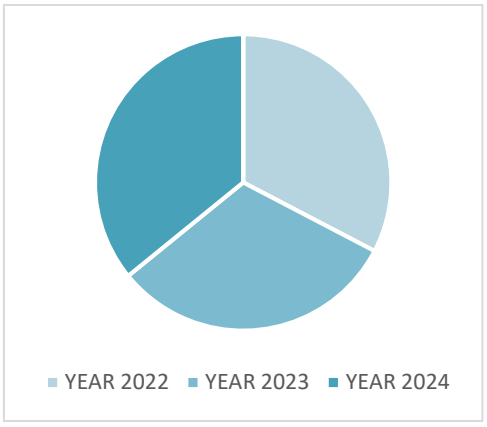

Figure 6. Total maize water consumption for the years 2022, 2023, and 2024

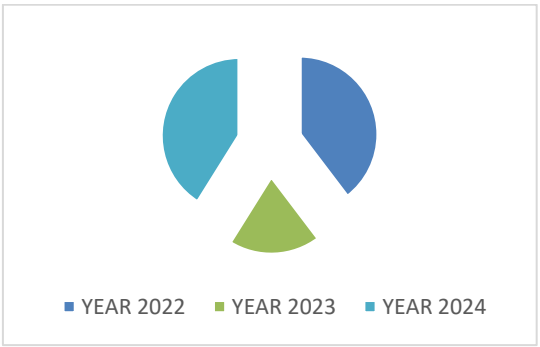

Figure 7. Water requirements of maize for the years 2022, 2023, and 2024

Based on the performed calculations, rainfall covered approximately 68% of maize water consumption in 2022, 100% in 2023, and only 52% in 2024, the latter being a year with significantly lower precipitation compared to the multiannual average for the area, as shown in Figures 6 and 7.

CONCLUSIONS

Following the analysis of the three years included in the study, it was found that 2022 was a warm and dry year, with an annual mean temperature lower than that of the other analyzed years (2023 and 2024), but higher than the multiannual average. The recorded precipitation in 2022 was below the multiannual average of the studied area. 2023 was a warm but also the rainiest year, while 2024 was the driest and hottest year among those analyzed.

The indirect methods used to determine the water consumption of maize were influenced by the climatic conditions of the studied years. The highest water consumption was recorded in 2024, followed by 2022, while 2023 registered the lowest values.

The highest monthly water consumption values, during the three years of study, were recorded in the summer months — June, July, and August — ranging between 866 m^3/ha and 1469 m^3/ha.

Regarding the coverage of maize water consumption from precipitation under the climatic conditions of Socol, Caraș-Severin County, it was found that in 2022 the crop's water demand was covered by rainfall in a proportion of 68%.

In 2023, a warm and the most humid year, the maize water consumption was fully covered (100%) by rainfall.

In 2024, the hottest and driest year of the three analyzed, rainfall covered only 52% of maize water consumption.

It is recommended that the water deficit not covered by rainfall in 2022 and 2024 be compensated by the application of irrigation.

Considering that irrigation should play only a supplementary role (covering approximately 25–30% of the total water demand), it is recommended to use either sprinkler irrigation or drip irrigation systems.

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