THE EFFICIENCY OF IRRIGATION IN CORN CULTIVATION UNDER THE IMPACT OF CLIMATE CHANGE IN SOUTHEASTERN ROMANIA: ADAPTATION AND OPTIMIZATION. A REVIEW

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Abstract

Climate change significantly affects corn cultivation in Romania, leading to an increase in the frequency of droughts and heatwaves, as well as changes in precipitation patterns. In this context, irrigation becomes a crucial solution for maintaining production stability and reducing the risk of agricultural losses.This study analyzes the impact of irrigation systems on corn cultivation, highlighting effective methods of water management under water stress conditions. Different irrigation techniques, such as drip and sprinkler irrigation, were evaluated to optimize water application during the critical stages of plant development.Additionally, the research addresses the genetic adaptation of corn to new climate conditions through the use of drought- and heat-resistant hybrids, which can sustain productivity even during periods of extreme stress.Through climate and agricultural models, we estimated the long-term impact of climate change on corn yields, proposing adaptation scenarios based on sustainable practices, crop rotation, and technological innovations. The results show that optimized irrigation and the selection of climate-adapted hybrids can significantly reduce production losses and support Romanian agriculture in the face of challenges generated by climate change. Our study emphasizes the importance of implementing long-term strategies to maintain sustainable corn production and presents viable solutions for Romanian farmers in the context of current and future climate changes.

Key words: corn, irrigation, climate change, drought, resistant hybrids

INTRODUCTION

If global climate change forecasts come to fruition, agriculture in Southeastern Europe will become increasingly threatened. In contrast to Northern Europe, where the global climate change scenario predicts an increase in agricultural productivity (Iglesias et al., 2012, Moriondo et al., 2010), areas suitable for agricultural production will decrease in Southeastern Europe due to dry climatic conditions.The increasing demand for food and energy has generated a higher need for global corn (Zea mays L.) production. However, environmental factors such as high temperatures and drought have continued to affect corn production in many regions over the past few decades, and this decline is expected to intensify in the context of climate change (Meeks et al., 2013).The development of corn hybrids capable of performing well under heat and

drought conditions is essential to support future agricultural progress. These traits include shortening the flowering-pollination interval (ASI), delaying leaf senescence, deepening and densifying roots, osmotic adjustment, a large number of leaves, reduced plant height, performance under low nitrogen conditions, seedling vigor, and the presence of epicuticular wax (Betran et al., 2003; Ludlow et al., 1990; Wan et al., 2000; Meeks et al., 2013). Such objectives are a priority in breeding programs worldwide, including in Romania. Drought tolerance, a complex trait, significantly complicates the methods for efficient selection, breeding, and evaluation. Corn is an extremely valuable species due to its high production potential, diverse uses in food and feed, as well as its role as a raw material in industrial processes.Widely cultivated globally and in Romania, corn supports the development of a modern agricultural market. Market and consumer demands influence corn breeding research, driving the creation of high-performance hybrids in terms of production capacity (Sarca et al., 1996). Corn (Zea mays L.) is an important forage plant due to its high dry matter yield and superior quality for optimal livestock production (Roth et al., 1995). The yield and quality of forage depend on the complex interaction between environmental, agricultural, and genetic factors. Drought and soil water deficit significantly affect grain and forage yields (Hajibabaei & Azizi, 2012). Corn has a high potential for grain production, mainly influenced by the hybrid's genetics and the environmental factors that affect plant development (Ion et al., 2014).The production capacity is determined by essential yield factors for its formation (Ion et al., 2013), and the varied responses of hybrids to water stress are observed at different growth stages (Mandache et al., 2012). Research on water consumption for irrigating corn is a major objective, given the importance of this crop for plant production (Popa, 2021). Globally, drought and desertification affect approximately 47% of arid lands, with varying degrees of aridity. The expansion of drought-affected areas and the reduction of water resources for irrigation have been observed in recent years in most regions of Romania (Huma, 2004).Drip irrigation "has the potential to double crop yields, including for most vegetables, cotton, sugarcane, and grapevines" (Postel, 2000). Drip irrigation, an advanced and water-efficient method, ensures the maintenance of plant roots in optimal moisture conditions for extended periods, thus promoting both physiological activity and crop development (Yan et al., 2022).The selection of an appropriate irrigation scheduling strategy is essential for supporting the physiological processes of plants and, consequently, for maximizing production (Kumar Jha et al., 2019). Additionally, efficient irrigation scheduling helps reduce water and energy consumption (Souza & Rodrigues, 2022). Romania, as a member of the European Union, faces the challenges of the market economy and the global financial crisis, and achieving high and stable yields, alongside economic efficiency and environmental protection, has become an urgent priority. In southeastern Romania, an average irrigation rate of 800-1500 m³/ha is recommended.The lack of irrigation during the maximum water consumption period for corn can negatively affect grain yield.Soil health maintenance through conservation methods, such as reduced tillage and partial retention of crop residues, improves soil fertility and its ability to support higher and quality yields. In contrast, conventional practices may limit the availability of essential nutrients, thus negatively affecting productivity (Călina, J et al. 2021). Levelled sandy soils exhibit

greater compaction and lower total porosity, which limits nutrient access and reduces fertility. Maintaining an unlevelled structure can contribute to better moisture and humus conservation, both essential for supporting healthy vegetation and humification processes (C.Popecu et al. 2024). Compaction, acidity, and low humus content negatively influence the productivity of agricultural crops. The application of complex land improvement works is essential to enhance fertility and support higher and more stable agricultural yields (C. Popescu & Bălan, 2024). Under conditions of reduced rainfall, especially in southern areas, irrigation becomes an indispensable solution for maintaining an optimal soil water regime and supporting agricultural production (Bălan, M., & Popescu, C. ,2024).

MATERIALS AND METHODS

This literature review analyzes publications related to corn cultivation in various production systems, including traditional agriculture and modern irrigation technologies. It draws on databases such as Science Direct, Scopus, and Web of Science, as well as relevant books. The main criteria for selecting publications focused on the topic of improving advanced technologies used to increase yield per unit area, including the use of drip irrigation techniques and precision agriculture.

RESULTS AND DISCUSSIONS

Studies have shown that drip irrigation helps reduce soil salt ion levels near the dripper, creating a favorable environment for plant growth in the root zone and mitigating the negative effects of soil salinization on crop development (Zhang et al.,2019). Agronomic approaches, such as adjusting sowing dates, nutrient management, water administration, the use of plant hormones, and osmoprotectants, should be significantly implemented to mitigate the negative effects of climatic parameters (Mustafa et al., 2023). The impact of climate change on the yields of major agricultural crops worldwide is expected to be negative (Roudier et al., 2011), while the exact effect remains highly uncertain when high temperatures, increased atmospheric CO2 concentrations, and changes in precipitation patterns occur simultaneously (Roudier et al., 2011). In Romania, the effects of climate change are being felt through rising temperatures, altered precipitation patterns, melting glaciers and snow, and rising sea levels.Extreme weather events, which cause negative environmental impacts (floods and droughts), are expected to become more frequent and intense in many regions (Rummukainen, 2012).The effects on ecosystems, economic sectors, public health, and vulnerability vary significantly from one region to another (Daniel et al., 2019).

CONCLUSIONS

Climate change significantly impacts corn production in Romania, especially in vulnerable regions such as the southeastern part of the country,through increased frequency of droughts, heatwaves, and altered precipitation patterns.Extreme weather events (droughts, floods) and soil degradation (compaction,acidity, salinization) are major limiting factors for agricultural productivity.
Drip irrigation has proven to be an effective method for increasing corn yields, reducing soil salinization, and optimizing water use. Under irrigated conditions, semi-late hybrids have better utilized available resources, demonstrating their maximum yield potential. The use of drought- and heat-resistant hybrids is essential for maintaining production under climatic stress conditions. Characteristics such as shortening the flowering-pollination interval and deepening root systems contribute to their increased tolerance.Precision agriculture, drip irrigation, and adjusting the agricultural

calendar are crucial strategies for adapting to climate variability. Soil conservation practices, such as retaining crop residues and minimal tillage, help maintain fertility and improve water retention. The compaction of sandy soils and low humus content can be countered through the application of land improvement practices, thereby increasing productivity. Implementing long-term strategies that combine efficient irrigation, the selection of adapted hybrids, and sustainable soil management is vital to addressing the impacts of climate change. Future research should integrate climate prediction models with modern agricultural technologies to ensure the sustainability of corn production in Romania.

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