

THE INFLUENCE OF SOIL TYPES AND CLIMATE CHANGE ON RYE YIELD IN BIHOR COUNTY

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RESEARCH ARTICLE

Abstract

The research aimed to assess the impact of climate change and the influence of soil types on rye production in Bihor County. The experiment was carried out in a bifactorial design including four fertilization variants (control variant, organic matter variant, chemical fertilizer variant and NPK + organic matter combined fertilizer variant), the research was carried out over a period of two agricultural years. In the context of climate change, the rye crop (*Secale cereale L.*) stands out as one of the most reliable cereal crops in the area of Derna commune, Bihor County, an area characterized from a pedological point of view by a great diversity of soil, brown forest soils and alluvial soils. (according to Annex to H.C.L. no. 66 of 18.08.2021) Brown forest soils are less fertile, but by administering amendments and fertilizers, they can give good quality crops. The results showed a high tolerance of rye crops to the pedoclimatic conditions specific to the studied area, maintaining stable yields (3t/ha in the case of the control variant and 4.8 t/ha in the case of mixed fertilization).

Keywords: rye, climate change, marginal soils, ecological plasticity.

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INTRODUCTION

Rye (*Secale cereale L.*), is one of the oldest cereal crops cultivated in Europe, standing out for its special adaptability to difficult pedoclimatic conditions. In the current context of climate change, this species is gaining importance in temperate zones, helping to maintain the agroecological balance. Unlike wheat and barley, rye tolerates marginal soils and low winter temperatures very well. (Victor Starodub 2008)

Rye (*Secale cereale L.*) has a high capacity to stabilize the soil and prevent its erosion. From a nutritional point of view, rye has a high content of proteins, fibers and essential minerals, being used both in human food (bread, bakery products) and in animal feed.

The stability of its production under pedoclimatic conditions in the municipality of Derna makes it a valuable alternative compared to other cereals, contributing to food security and the adaptation of agriculture to climate change.

Rye is distinguished by a deep root system, capable of efficiently extracting water and nutrients from the lower layers of the soil,

which gives it a resistance to drought and is also recognized for its tolerance to diseases and pests, thus the rye crop reduces the need for chemical inputs, contributing to the protection of the environment and maintaining the natural fertility of the soil. (Victor Starodub -Chisinau 2008)

From a pedological point of view, the Derna commune is characterized by a diversity of soils, in general, the predominant soils are brown forest soils and alluvial soils. The climatic data are generally characterized by the geographical location of the commune, characterized by a moderate temperate continental climate.

The gradual increase of the altitude of the relief on the territory of the commune from west to east entails a vertical leveling of all climatic elements. The average annual temperature rises to 9°C in the western part, and in the eastern part of the commune, on the Plopiș Mountains it remains at 8°C. The thermal value of January rises around -2°C, and in July, the monthly average rises to 19°C. The atmospheric precipitation that falls on the territory of Derna commune is 700 mm. The month with the highest rainfall is June, when 110 mm were recorded, while February is the

driest, when 40 mm were recorded. (according to Annex to H.C.L. no. 66 of 18.08.2021)

These pedological conditions offer the possibility of a relevant study on the relationship between soil, climate and reliability of rye crop performance.

It is assumed that the variety of soil types and climatic factors influences vegetative development and rye yield, and the ecological adaptability of the species allows it to maintain stable productions under diverse pedoclimatic conditions. (Blaga, Rusu, 2005)

The purpose of the research is to assess the influence of soil types and climate variability on the dryland crop in Bihor County, highlighting its potential to contribute to sustainable, resilient and efficient agriculture.

MATERIAL AND METHOD

The study area corresponds to Derna commune, Dernisoara village, the area located in the North-Eastern part of Bihor County, at the approximate geographical coordinates 47°14' N and 22°21' E, at an average altitude of about 200m. Figure 1.1



Figure 1. The Study area

The relief has a hilly character, with slightly inclined slopes, the area is not crossed by permanent rivers, drainage being provided by temporary surface runoff. The climate is temperate-continental with average annual temperatures of 9-9.5°C and precipitation of 600-700 mm, unevenly distributed throughout the year, with maximums in June-July and minimums in January-February.

The study was conducted on brown forest soils, soil with weak acid reaction (pH 6.0-6.5), humus content 2.5-3% and loamy texture. For the analysis, the varieties frequently used in the area were taken into account, with a good adaptability to local pedoclimatic conditions, characterized by:

- high resistance to wintering and drought;
- good twinning ability;

- medium to high waist;
- high protein content;
- vegetation period of 270-290 days;
- The research period was carried out on the results of consecutive agricultural years (2023-2024 and 2024-2025).

The experiment included five fertilization variants, applied on homogeneous plots, maintaining the sowing density of 400 germinable grains/m²:(Table 1).

- V0 - Control - No fertilization;
- V1 - Mineral -N90kg/ha, P60kg/ha, P60kg/ha;
- V2 - Organic – manure -30t/ha;
- V3 - Mixed - N60kg/ha, P40kg/ha, K40kg/ha, 20t/ha organic fertilizer.

The research hypothesis assumes that the type of soil and climatic variability are determining factors for the stability of rye productions in Bihor County, and the ecological adaptability of the species allows the maintenance of constant yields even in drought conditions or on lands with low fertility.

The general goal is to analyze the soil influences and climatic variability on rye production in Bihor County, with a focus on the area of Derna commune.

RESULTS AND DISCUSSIONS

The results of the research carried out in Bihor County, Derna commune, highlight the significant influence of the fertilization variants in the mentioned area on rye crops (Table 1). The pedoclimatic conditions in the study area, characterized by brown forest soils and a moderate continental temperate climate, allow stable yields even in the case of adequate fertilization even in the year with variable rainfall.

Table 1

Fertilization variants used in the experiment

Vari ant	Type of fertilization	Fertilization component	Note
V0	Control	No fertilization	Only basic work and sowing
V1	Mineral	N90kg/ha, P60kg/ha K60kg/ha	The optimal economical option
V2	Organic	Manure 30t/ha	Incorporated under the furrow 2-3 weeks before sowing
V3	Mixed	N60kg/ha, P40kg/ha K40kg/ha, 20t/ha organic fertilizer	Synergy between mineral and organic intake

The results of the average production show that the level of fertilization significantly influences production, and also the quality of the beans. Average production varied between

3.0 t/ha (control version) and 4.8 t/ha (mixed fertilization)(Table 2)

Table 2

Results obtained in the research period

Variant	Bloke fertilization	Yield Average t/ha	Mass at 1000 Grains (g)	Vegetation observations
V0	Control	3.0	35.4	Plants shorter, reduced foliage, density
V1	Mineral	3.8	37.5	Optimal spike density Uniform grain filling
V2	Organic	3.7	37.2	Improved soil structure and better drought resistance
V3	Mixed	4.8	38.9	Highest yields, vigorous plants and uniform grains

Higher increase in rye yield

It was recorded in the mixed version, which confirms the synergistic effect between mineral fertilizers and organic matter.

Soil types influence rye production as follows:

- on brown forest soils, the intake of organic matter is essential for improving the structure and increasing the moisture retention capacity.

Benchmarking and interpretation of results:

- rye (*Secale cereale* L.) has an ecological plasticity superior to wheat and barley, managing to ensure stable y in conditions of variable humidity;

On the soils of Derna, wheat generally registers 4.5-6.0 t/ha but is more sensitive to drought and acidity of the soils in the area compared to rye;

- autumn barley achieves a production of 4.0.-5.0 t/ha, but it is more difficult to tolerate loamy and compact soils;

- triticales are close to the performance of rye, but still have a lower resistance to frost and the pH of the soil in the commune of Derna.

Thus, under local conditions, rye surpasses other straw cereals in production stability, even in 2024, a year that was partly a dry year.

The fertilization effects have an important impact on rye cultivation technology in the area of Derna commune, namely:

- in the control V0 variant (the variant without fertilization) there was an average production of 3.0 t/ha and a mass of 1000 grains of 35.4 g. In this variant the plants were characterized by lower height, lower leaf mass and a density of plants per m² would have been reduced, indicating the low nutrient deficiency.

- the V1 variant (the variant with medium fertilization N90kg/ha, P60kg/ha, K60kg/ha) had a yield of 3.8 t/ha, being considered the optimal option from an economic point of view. The plants were characterized by a uniform growth of the ears and at the same time a

uniform filling of the grains, the mass of 1000 grains was 37.5 g.

- variant V2 (organic manure 30t/ha incorporated under the furrow 2-3 weeks before sowing) achieved a production of 3.7 t/ha and had a grain mass of 37.2 g/1000 grains, The application of organic fertilizers improved the soil structure and also increased the resistance to drought but still the production had a slight decrease compared to the average of the V2 variant which registered 3.8 t/ha.

- the V3 variant (N60kg/ha, P 40 Kg/ha, K40kg/ha, 20t/ha + organic fertilizer), recorded the highest production per hectare, namely 4.8 t/ha and at the same time the best grain filling, the mass of 1000 grains had a weight of 38.9. At this fertilization option, the plants developed vigorously, with a tall waist reaching 1.74 m, a rich leaf mass and a fully formed ear.

During the entire vegetation period, it was observed that the plants that benefited from fertilization had a better developed root system, while the plants from the control version showed visible nutrient deficiencies.

The comparative analysis of the variants shows a significant difference between the V0 control variant and the variants with fertilization.

During the years of observations (2023-2024 and 2024-2025), notable differences between years were highlighted, mainly determined by the rainfall regime and the type of fertilization applied.

The year 2023, a year with an optimal rainfall regime, maximum productions are obtained at V1 and V3.

The year 2024 was a partial dry year, the mixed fertilizer variants showed superior stability.

The year 2025 was characterized by periods of drought alternating with episodes of heavy rainfall.

The multiannual analysis confirms the resilience of rye crops and the efficiency of mixed fertilization in the variable climatic conditions in the hilly area of Bihor County, highlighting the importance of integrated soil management for maintaining stable yields in years with water stress.

The cultivation of this cereal is of high importance for agriculture in Romania, as it is the second bread cereal, after wheat, with the mention that it makes good use of marginal lands, including acidic ones. where wheat is not economically reliable.

CONCLUSIONS

The research were carried out in Derna commune, Bihor county had as its main objective the evaluation of the influence of soil types and climatic variability on rye production (*Secale cereale* L.) in the context of the increasingly evident climate changes in recent years. The results obtained confirm that this crop represents one of the most stable and adaptable cereal species, capable of maintaining a constant level of protection even in conditions of water or thermal stress.

Brown forest soils, although with lower natural fertility, responded favorably to the contribution of organic matter, which contributed to the improvement of structure, porosity and water retention capacity. This fact highlights the importance of applying balanced fertilization technologies, based on the principles of integrated soil management.

The results obtained show that fertilization has a decisive impact on the yield and quality of rye production. Control plots, without fertilization, achieved an average production of 3.0t/ha, reflecting the natural capacity of the soil without additional nutrient input. By applying mineral fertilization, the production progressively increased to 3.8 t/ha, especially due to the stimulation of the photosynthesis process and the formation of a larger number of ears. Organic fertilization has had a beneficial effect on soil structure and has helped to maintain high yields even in the partially dry year. However, the most efficient option proved to be mixed fertilization, this combination determined a maximum production of 4.8 t/ha, due to the synergistic effect between the rapid intake of nutrients and the long-lasting action of organic matter.

Also, a steady increase in the mass of 1000 grains was observed with the intensification of fertility, which indicated a more complete filling of the ear and a higher

quality of the grains. From an agronomic point of view, mixed fertilization contributes to maintaining soil fertility in the long term, thus being the most sustainable option for the conditions of the hilly area of Bihor. The analysis of the climate regime in the period 2023-2025 highlighted a significant variability in rainfall, one year more dry (2024) alternating with normal or slightly wetter years (2023), the year 2025 was characterized by periods of drought alternating with episodes of abundant rainfall. Despite these fluctuations, rye has demonstrated remarkable resistance, maintaining stable yields and adapting its phenology to humidity and temperature conditions. In the drier year, the production decreases were more pronounced in the plots without organic matter, while the variants with mixed and organic fertilization recorded minimal losses, confirming the role of organic matter in reducing the effects of water stress.

Compared to other cereal crops in the region such as wheat, barley or dry triticals, it was highlighted by a superior productive stability and a greater tolerance to acidic soils and drought conditions.

Wheat and barley, although capable of higher yields in favorable years, are more sensitive to climatic fluctuations and soil reaction, while rye manages to maintain a constant productive balance, even in limiting pedoclimatic conditions.

The integration of rye crops (*Secale cereale* L.) into the structure of local crops not only diversifies the agricultural production base, but also ensures a more efficient use of natural resources, supporting the maintenance of the agroecological balance in increasing the sustainability of agricultural systems in the temperate and hilly areas of Bihor County.

In the perspective of sustainable agriculture, the use of a balanced fertilization technology, adapted to the local pedoclimatic specificity, (Derna commune), rye cultivation can become an essential component of agroecological systems in hilly areas, contributing both to the stability of production and to the conservation of water and soil resources.

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