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THE EFFECT OF CHEMICAL FERTILIZATION ON WHEAT QUALITY PARAMETERS UNDER THE PEDOCLIMATIC CONDITIONS OF TIMIȘ COUNTY

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Abstract. *This paper aims to analyze the influence of chemical fertilization on the quality indices of wheat (Triticum aestivum L.) under the specific pedoclimatic conditions of Timiș County, an important agricultural region in western Romania. The study was conducted over two agricultural years, using the autumn wheat variety, cultivated on chernozem soil, under the influence of a moderately continental climate with Mediterranean influences. Differentiated doses of mineral fertilizers based on nitrogen (N), phosphorus (P), and potassium (K) were applied in various combinations and at different growth stages. The analyzed parameters included protein content, test weight (hectoliter mass), gluten content, amino acid profile, and protein quality—key indicators of wheat quality for baking purposes. The results showed a significant positive correlation between nitrogen fertilization and the increase in protein and gluten content; however, they also revealed potential reductions in test weight in cases of excessive nitrogen application. Furthermore, it was found that a balanced application of NPK led to superior production quality, with visible effects on the technological value of the wheat. The conclusions of the study emphasize the importance of adjusting fertilizer doses according to soil characteristics and local climatic conditions, in order to achieve an optimal balance between yield quantity and quality. The results may serve as a practical guide for farmers and agronomy specialists in the western region of the country.*

Keywords*: wheat quality, chemical fertilization, nitrogen, phosphorus, potassium, Timiș County, protein content, gluten*

INTRODUCTION

Wheat *(Triticum aestivum L.)* represents one of the most important cereal crops worldwide, providing a major source of carbohydrates and proteins for human nutrition. In Romania, wheat plays a strategic role in agricultural production systems, especially in the western part of the country, where soil fertility and climatic conditions favor high productivity. However, beyond yield, wheat grain quality has become a critical criterion for market value, milling performance, and baking suitability.

Grain quality parameters such as protein content, gluten characteristics, thousand kernel weight (TKW), and hectoliter weight are strongly influenced by fertilization practices. Among mineral nutrients, nitrogen (N) is considered the most important factor affecting protein synthesis and gluten formation, while phosphorus (P) contributes to energy metabolism and root development, and potassium (K) plays a key role in carbohydrate transport, enzyme activation, and grain filling processes.

Excessive or unbalanced chemical fertilization may lead to inefficient nutrient use, environmental pollution, and deterioration of grain quality. Consequently, modern research increasingly focuses on optimizing fertilizer doses and application strategies in order to achieve both high productivity and superior quality under specific pedoclimatic conditions.

Timiș County is characterized by fertile chernozem soils and a temperate continental climate, offering favorable conditions for wheat cultivation. Nevertheless, variations in nutrient availability and fertilization management can significantly affect wheat grain quality. In this

context, evaluating the response of wheat quality parameters to different NPK fertilization regimes is essential for developing sustainable and efficient agricultural practices.

The objective of this study was to assess the effect of different chemical fertilization variants, based on varying doses and application strategies of nitrogen, phosphorus, and potassium, on wheat quality parameters under the pedoclimatic conditions of Timiș County. A particular emphasis was placed on innovative indicators such as nitrogen use efficiency and protein yield, in addition to classical quality traits.

MATERIAL AND METHODS

1. Experimental Site

The field experiment was conducted during the 2023–2024 agricultural year on an experimental field located in Timiș County, western Romania, at the Didactic Station of the University of Life Sciences "King Mihai I" of Timișoara. The area is representative of the Banat Plain and is characterized by a chernozem soil, with moderate humus content, neutral to slightly alkaline reaction, and good nutrient supply.

The climate is temperate continental, with an average annual temperature of approximately 11–12 °C and multiannual precipitation between 550 and 600 mm, conditions generally favorable for wheat development.

2. Experimental Design

The experiment was arranged as a randomized complete block design, including five fertilization variants, each replicated four times. The experimental plots were uniformly managed in terms of tillage, sowing density, and crop protection measures.

3. Fertilization Variants

Table 1

Fertilization variants applied in the experimental field

Variant	Fertilization treatment	Dose (kg ha^{-1} active substance)
V0	Unfertilized control	-
V1	N60P40K40	60 N – 40 P_2O_5 – 40 K_2O
V2	N90P60K60	90 N – 60 P_2O_5 – 60 K_2O
V3	N120P80K80	120 N – 80 P_2O_5 – 80 K_2O
V4	Split N + balanced PK	120 N (60+60) – 60 P_2O_5 – 60 K_2O

Nitrogen was applied as ammonium nitrate and urea, phosphorus as triple superphosphate, and potassium as potassium sulfate. In variant V4, nitrogen was applied in two split doses: one at tillering and one at stem elongation, in order to improve nitrogen uptake efficiency and grain quality.

4. Wheat Quality Analyses

After harvest, grain samples were collected from each experimental plot and analyzed in laboratory conditions. The following quality parameters were determined:

- Grain protein content (%) – Kjeldahl method
- Wet gluten content (%)
- Gluten deformation index
- Thousand kernel weight (TKW, g)
- Hectoliter weight (kg hl^{-1})
- Protein yield (kg ha^{-1})
- Nitrogen use efficiency (NUE)

Thousand kernel weight was determined by weighing 1000 grains randomly selected from each sample, providing an indicator of grain size and degree of grain filling.

5. Statistical Analysis

The experimental data were statistically processed using analysis of variance (ANOVA). Differences between treatments were evaluated using the Least Significant Difference (LSD) test at a probability level of $p \leq 0.05$. Correlation analysis was performed to assess relationships between fertilization intensity and wheat quality parameters.

RESULTS AND DISCUSSIONS

1. Effect of Fertilization on Protein and Gluten Content

Chemical fertilization had a significant effect on wheat grain protein and gluten content. Protein concentration increased progressively with increasing nitrogen doses, confirming the central role of nitrogen in protein synthesis.

Table 2

Effect of fertilization on wheat grain quality parameters

Variant	Protein (%)	Wet gluten (%)	TKW (g)	Hectoliter weight (kg hl^{-1})
V0	10.2	21.5	39.8	74.2
V1	11.6	24.8	41.2	76.1
V2	12.8	27.3	42.6	77.4
V3	13.9	29.1	43.0	78.2
V4	14.3	30.4	42.8	78.0

The highest protein and gluten values were recorded in variant V4, indicating that split nitrogen application enhanced nitrogen availability during critical growth stages.

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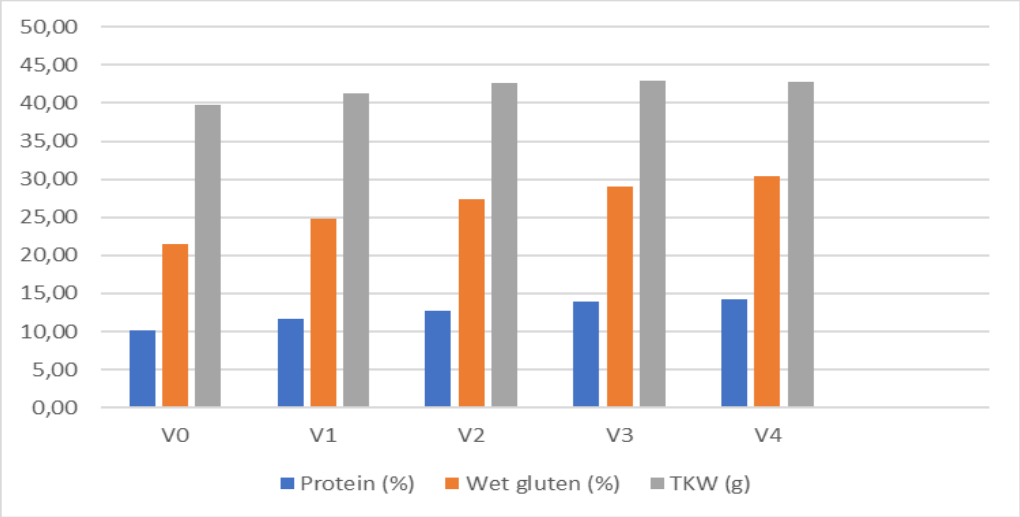

Figure 1. Effect of different NPK fertilization variants on wheat grain quality parameters

2. Thousand Kernel Weight Response

Thousand kernel weight showed a positive response to balanced NPK fertilization. Moderate and balanced fertilization (V2 and V4) resulted in the highest TKW values, reflecting improved grain filling and assimilate translocation.

Excessive nitrogen doses (V3) slightly increased TKW, but the improvement was less pronounced, suggesting that potassium availability played a decisive role in carbohydrate transport toward the grain.

3. Nitrogen Use Efficiency and Protein Yield

Nitrogen use efficiency was highest in variant V4, despite having the same total nitrogen dose as V3. This demonstrates that fertilizer management strategy is more important than fertilizer quantity alone.

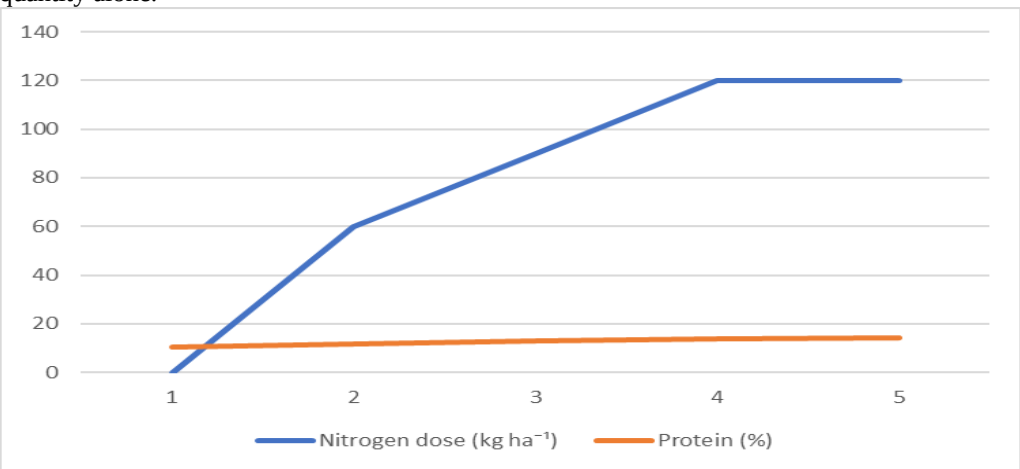

Figure 2 Relationship between nitrogen fertilization rate and wheat grain protein content.

Protein yield followed a similar trend, with maximum values recorded under split nitrogen application, highlighting the agronomic and environmental advantages of optimized fertilization regimes.

CONCLUSIONS

The results of this study indicate that chemical fertilization significantly influences wheat quality parameters under the pedoclimatic conditions of Timiș County. Nitrogen had the strongest effect on protein and gluten content, while balanced phosphorus and potassium fertilization improved grain physical traits such as thousand kernel weight and hectoliter weight.

The innovative fertilization variant based on split nitrogen application demonstrated superior nitrogen use efficiency and protein yield compared to single-dose applications. These findings emphasize the importance of balanced and strategically applied fertilization in achieving high wheat quality while minimizing environmental risks.

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