THE EFFECT OF WEATHER CONDITIONS ON YIELD AND QUALITY OF SOME VARIETIES OF WHEAT CULTIVATED AT ARDS SIMNIC

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Abstract

The continuous increase of the world population raises one of the most delicate problems, namely the provision of food for mankind. In recent decades, world food production has increased quite a bit. The most effective way to enrich mankind's food resources is to increase the agricultural production per hectare on the current arable land areas, by introducing new varieties and productive hybrids and by improving the cultivation technology. Thus, the variability of production and protein content of 10 common winter wheat genotypes, depending on the climatic and fertilization conditions, was experimented at the Agricultural Development Research Station (ARDS) Șimnic – Craiova during 2020-2023.

As a result of the research carried out, it was found that the tested varieties behaved differently both in terms of production and its quality.

Key words: fertilization, protein, yield, winter wheat

INTRODUCTION

Over the past two decades, the global agricultural production volumes of primary crops showed a steady upward trend to meet the worldwide expanding demand. The recorded growth rate of 56 percent between 2000 and 2022 was facilitated by the enhancement in production technologies and the intensification of farming activities, particularly with increased use of irrigation, pesticides, fertilizers and high-yield crop varieties, and cropland expansion, while facing the adverse effects of climate change (FAO, 2023).

Wheat is presently the most widely grown crop in the world, grown on 217 million hectares per year with a total world production exceeding 700 million tons, due to its many favorable qualities for human nutrition (Erenstein, O. et al., 2022). It is vital to increase wheat yield in accordance with the nation's rapid population growth (Maqbool, A. et al., 2023). Owing to the uneven harvests wheat in recent years both in terms of quality and in terms of quantity, a particularly important aspect for this food sector is the correct analysis of quality of raw materials in order to orient it towards bakery and pastry products and for determining appropriate corrective methods for improving the quality of wheat and wheat flour obtained by grinding in order to obtain constant quality finished products (Dodocioiu Ana et al., 2015).

In recent years, the production of wheat grain has increased globally, but its quality has not improved, which can have a negative impact on animal and human health (Francess Sia Saquee, et al., 2023).

Doses of nitrogen fertilizers may be accompanied by harmful effects for plants and may be removed if a fraction of the dose of nitrogen was applied in the late stage of plant development, while vegetative growth is terminated, and nitrogen is used in the

formation of the reproductive organs, and for synthesis of protein in the grain as reserve substance thus improving quality traits of flour (Mocanu, R. et al., 2013, Dodocioiu Ana et al., 2013).

The optimal fertilization and nutrition by macro and micro elements without insufficient or excess stages favor a normal dynamic of the accumulation of the nutritive elements and dry matter (Mocanu, R. et al., 2009). Of this normal parallelism (nutrient – dry matter) we can trace the obtaining of high and quality yields (Hera, C. and Idriceanu Alina, 1987). Also, the application of humic and fulvic acids at optimal concentrations can be an alternative to chemical fertilization, with an effect on plant growth and development, as well as changing the bioavailability of nutrients in the soil. These products and methods of fertilization are modern technologies with a positive impact both economically and on the environment (Soare, M. et al., 2020).

The fertilization significantly determines the protein quantity per surface unit, especially through nitrogen fertilizers. Even though the phosphorus does not influence as much as the nitrogen the yield quantity and the protein content it sustains the nitrogen effect and alleviate the negative influence of high nitrogen doses on the quality and quality of the protein determining a better assimilation and metabolisation of the absorbed nitrogen forms (Rusu, M. et al., 2005).

The purpose of this study was to identify the behavior of 10 common winter wheat genotypes grown at ARDS Șimnic - Craiova. Grain production and protein content were monitored, during three years in the local climatic conditions.

MATERIALS AND METHODS

The experiments were located in the experimental field of SCDA Șimnic, according to the method of randomized blocks, in three repetitions, in the period 2020-2023.

The biological material was represented by 10 Romanian wheat varieties. Of these, the Glosa variety was used as a control. The experiments were carried out under non-irrigated conditions.

The tillage and cultivation technology applied were standard for wheat cultivation. Sowing each year was carried out in October.

The soil on which the experiment was placed is a reddish preluvosol, with Lower Pleistocene fluvial terrace deposits as parent material, with semi-adjacent rock, gravels, sands and clays, with a water table depth of 10 m. The soil profile is of the type: Ap, Apt, AB, Bt, Bt2, BC, Cr, Ck.

The soil has the following physical and chemical properties in the Ap horizon (0-27cm): coarse sand: 7.0%; fine sand: 39.7%; dust: 21.8%; clay: 31.9%. Textural class: LL. Apparent density: 1.26g/cm3; PT=52.2%; PA=20.75%; CA=5.4%; CO=8.1%; EU=14.7%; pH=5.35, the soil reaction being moderately acidic; humus=2.7%, medium ensured; Nt = 0.073%, medium supplied; PAl = 52 mg/kg, well supplied; KAL=127 mg/kg, medium stocked. The soil falls into the III class of quality according to the credit score of 58 points.

Fertilization was identical in all variants as follows:

- in 2020, the doses of N170P50 provided by 350 kg/ha ammonium nitrate and 250 kg/ha complex 20-20-0 were used.
- in 2021, the doses of N147P69 were used, which were provided by 350 Kg/ha of ammonium nitrate applied in the spring and 150 kg/ha of complex 18-46-0 applied before sowing.
- in 2022, doses of N170P50 were used which were provided by 250 Kg/ha of 20-20-0 complex applied before sowing and 350

Kg/ha of ammonium nitrate applied in the spring.

Climatic conditions during the years of experimentation

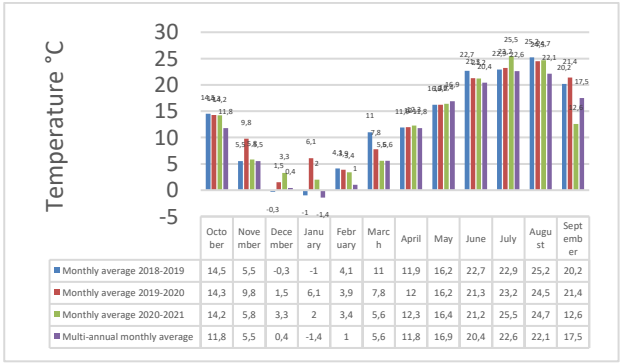
As can be seen from figures 1 and 2, the year 2020 was the most favorable year for wheat cultivation, with precipitation and temperature values closer to the multiannual average. Thus, the precipitation exceeds the multi-year average exactly when it was necessary, namely in October and November, helping to good germination and growth, as well as in May-June, to the formation of the ear and grain.

The temperatures were within accessible limits, registering slightly lower temperatures in the summer, thus helping the formation of the grain.

In 2021, higher temperatures were recorded in almost every month of the growing season except for May, which was 0.7^{0}C lower. In June, during the formation of the grain, the temperatures were higher by 0.9^{0}C, which led to its shattering.

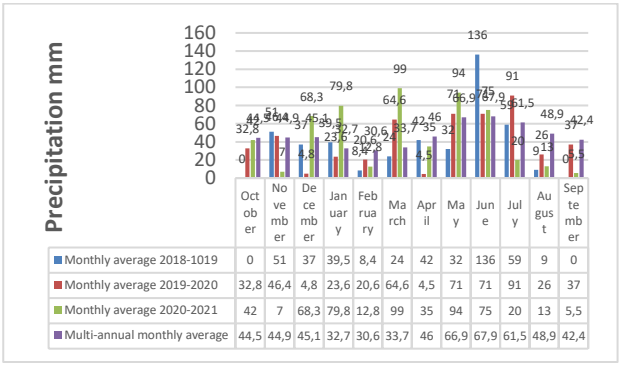
Precipitation was also lower in 5 months of the 9 months of the vegetation period, being very low at sowing, the emergence did not occur on time, and 41.5 mm lower in April when the plants needed to form the ear.

In 2022, the climatic conditions were less favorable for the development of wheat. Precipitation was below the multi-year average by -13.7 mm and temperatures were 0.5^{0}C higher.



	October	November	December	January	February	March	April	May	June	July	August	September
Monthly average 2018-2019	14,5	5,5	-0,3	-1	4,1	11	11,9	16,2	22,7	22,9	25,2	20,2
Monthly average 2019-2020	14,3	9,8	1,5	6,1	3,9	7,8	12	16,2	21,3	23,2	24,5	21,4
Monthly average 2020-2021	14,2	5,8	3,3	2	3,4	5,6	12,3	16,4	21,2	25,5	24,7	12,6
Multi-annual monthly average	11,8	5,5	0,4	-1,4	1	5,6	11,8	16,9	20,4	22,6	22,1	17,5

Figure 1. Temperatures for the experimentation years



	October	November	December	January	February	March	April	May	June	July	August	September
Monthly average 2018-1019	0	51	37	39,5	8,4	24	42	32	136	59	9	0
Monthly average 2019-2020	32,8	46,4	4,8	23,6	20,6	64,6	4,5	71	71	91	26	37
Monthly average 2020-2021	42	7	68,3	79,8	12,8	99	35	94	75	20	13	5,5
Multi-annual monthly average	44,5	44,9	45,1	32,7	30,6	33,7	46	66,9	67,9	61,5	48,9	42,4

Figure 2. Precipitations from the experimentation years

RESULTS AND DISCUSSIONS

Yield analysis

Comparing the average annual yields of the three years of experimentation, the highest average value was recorded for the year 2020, a value that is significantly distinguished from the other two calculated average values. Wheat grain yield is highly dependent on genetic and environmental factors: nitrogen availability, water, temperature and management practices (Iancu Paula et al., 2019).

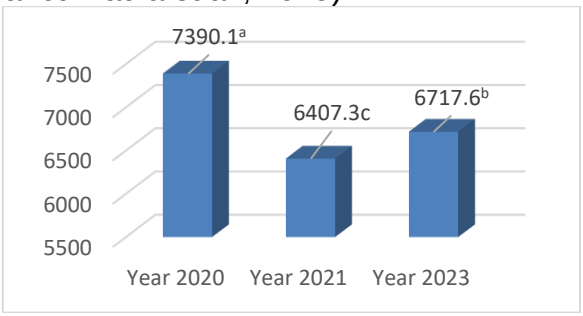


Figure. 3. Variation in average annual yields recorded in the three years of experimentation (Kg/ha)
LSD 5%=488.51 kg/ha

The highest average yield value was recorded for the Pajura variety, a value that significantly exceeds the last 6 classified genotypes. The lowest value was recorded for the Șimnic 30 variety, a value that is significantly exceeded by the first 7 classified genotypes.

Variety is the first characteristic that must be carefully analyzed to the establishment of a culture and especially its genetic heritage – it is or not a variety suitable for yielding quality wheat for bread (Matei, Gh. and Dodocioiu, A.M., 2016). Also, on less fertile soils, where precocity

and rusticity are important advantages, the very early Simnic 30 variety is recommended (Matei, Gh. et al., 2017).
The assortment of varieties recommended for each crop area can be chosen based on the data obtained from the multiannual tests, in natural and artificial conditions and taking in account their behavior and stability of yields (Iancu Paula et al., 2017).

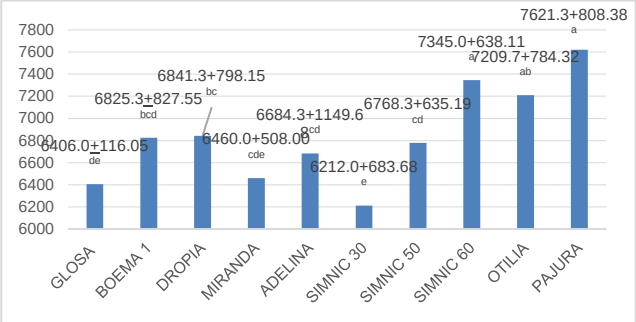


Figure 4. Variation of the average grain production of wheat varieties tested at SCDA Șimnic (kg/ha)
LSD 5%= 425.01 kg/ha

Related to the coefficient of variability calculated for the average grain yields of wheat varieties tested at SCDA Șimnic (kg/ha), the first and second calculated values are significantly distinguished from all other lower values.

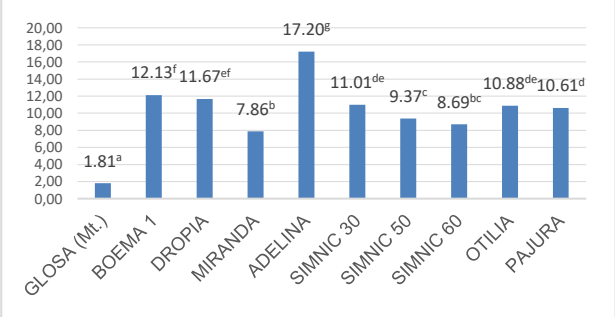


Figure 5. Variation of coefficients of variability calculated for average grain yields to wheat varieties tested at SCDA Șimnic (%)
LSD 5%=1.21%

For the analysis of the correlation between average grain yield and, respectively, the coefficient of its variability, a value of 0.179 was calculated, which implies that there is no connection between the two variables. In other words, genotypes with high biological yield potential do not show high genetic variability of this character over time.

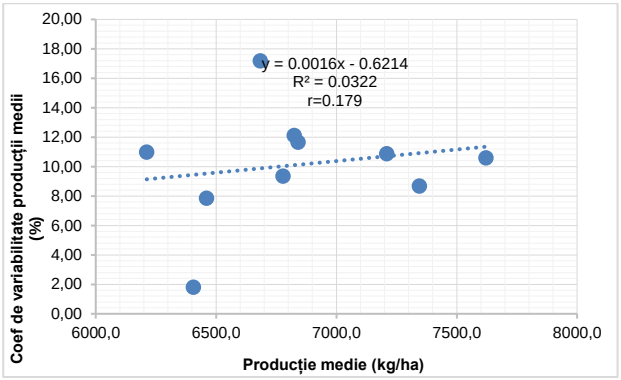


Fig. 6. Correlation analysis between average grain yield and coefficient of its variability to wheat varieties tested at SCDA Șimnic (Kg/ha)

Yield quality

It was appreciated by the amount of protein contained in the harvest of each variety. The results regarding this annual indicator are presented in figure 7.
Regarding the average grain protein content, the highest value of this index was calculated for the year 2023, a value that is significantly different from the other two average values calculated. This is due on the one hand to the climatic conditions, and on the other hand to the fact that larger amounts of nutrients have been accumulated in the soil for 3 years. According to Biary, A. et al. (2011), the reason for the increase in the protein following the use of nitrogen biofertilizer is the provision of nitrogen through biological fixation and the release of the absorbable nitrogen on plant roots by bacteria. In other words, the increase is associated with the better supply of nitrogen for grain and the higher nitrogen efficiency (Sharif, R. and Lotfollah, F., 2017).
Thus, during the period of the bellows and grain formation, the temperature was lower than in other years and the precipitation was higher.
A major problem is crop adaptability to environmental conditions, especially temperature and humidity (Soare Rodica et al., 2019).

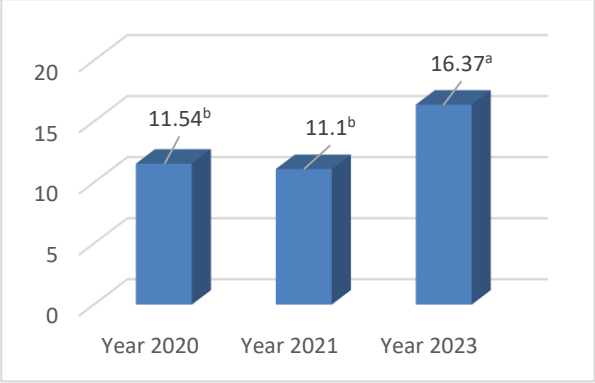


Figure 7. Variation in the average grain protein content recorded in the three years of experimentation (%)
LSD 5%=0.785%

On average over the three years of experimentation, the amount of protein was between 12.07% in the control (Glosa variety) and 13.77% in the Șimnic 30 variety (Figure 8). The interaction between year and biofertilizer had a significant effect on the grain protein content at the probability level of 5% (Abolghasem, M. et al., 2021).
The highest recorded value of the average protein content was recorded in the Șimnic 30 variety, a value that significantly exceeds the last 7 classified genotypes. The lowest value was recorded for the Glosa variety, a value that is significantly exceeded by the first 7 classified genotypes.

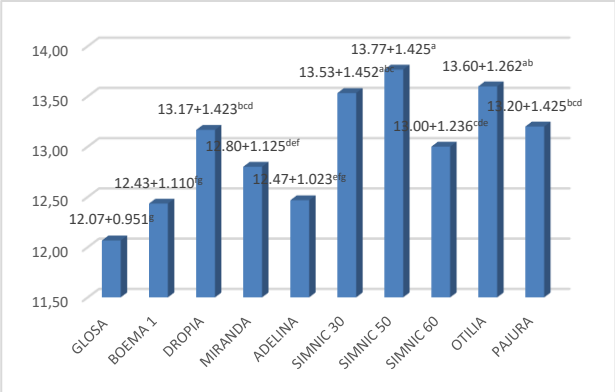


Figure 8. The variation of the average protein content in wheat varieties tested at SCDA Șimnic (%)
LSD 5%=0.56%

Hammad, A. et al. (2020) observed the improvement in soil fertility and protein contents of wheat grains following application of organic fertilizers. However, they also reported that synthetic fertilizer resulted in the highest grain yield (Ehsan, N. et al., 2021). In an experiment with DH lines, Soare, M. and Iancu Paula (2022) confirmed the genetic potential for high quality of these so that, selection of new genotypes with desirable traits from the genetic diversity is crucial for the adaptability and survival of wheat under climate fluctuations, which are expected to become a major constraint for plants potential in the future.
The use of micronutrients mixed with macronutrients significantly increases plant growth, physiological traits, yield components, the yield, and most grain quality traits (Francess Sia Saquee et al., 2023).
Regarding the variation coefficient of variability calculated for the grain protein content of the wheat varieties tested at SCDA Șimnic, the highest values were calculated for the Simnic 30 and Miranda varieties, respectively.

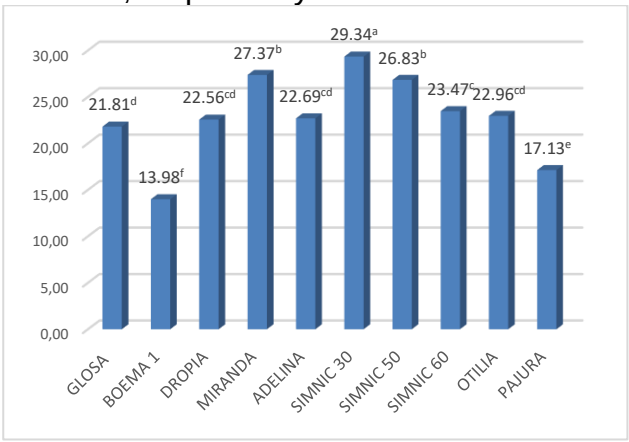


Figure 9. Variation of the coefficients of variation calculated for grain protein content to wheat varieties tested at SCDA Șimnic (%)
LSD 5%=1.852 %

Related to the analysis of the correlation between grain protein content and, respectively, the coefficient of its variability, a value of 0.135 was calculated, which implies that there is no connection between the two variables. In other words, genotypes that have a high grain protein content do not show high genetic variability of this character over time.

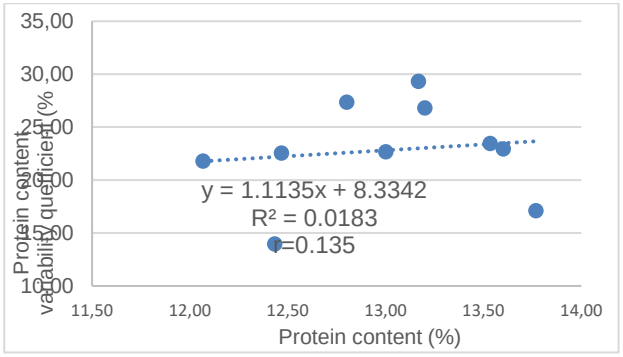


Figure 10. Correlation analysis between grain protein content and coefficient of its variability in wheat varieties tested at SCDA Șimnic (kg/ha)

In the case of the analysis the relationship between grain protein content and grain yield, the coefficient of correlation is presented in figure 11. Thus, it can be seen that the strongest link between the two indices was identified in the year 2021, the year in which both the average grain production and the average grain protein content recorded the highest small average values, in the other two years of experimentation the coefficient values of the calculated correlation being very low.

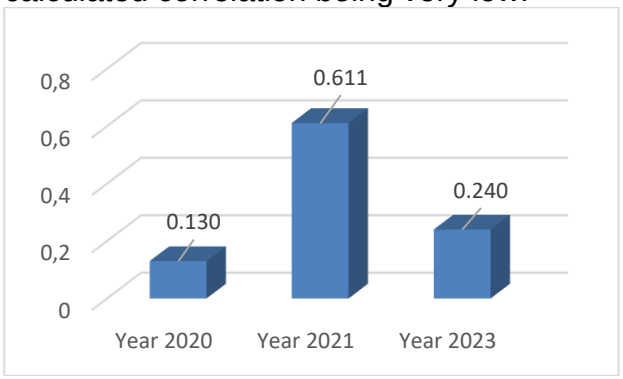


Figure 11. The variation coefficient of correlation between grain protein content and grain yield

Thus, analyzing the value evolution of the protein content according to the increasing trend of grain production, in 2020 it can be seen from figure 12 that this index has a sinusoidal evolution, a situation that justifies the very low value of the coefficient of correlation between the two indices.

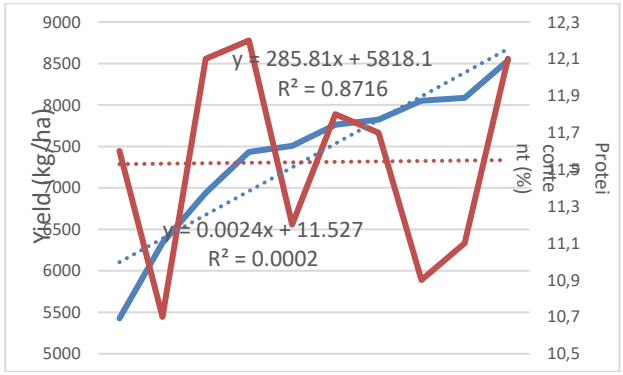


Figure 12. Variation in the evolution of protein content according to the increasing trend of grain production in 2020

In the year 2021, where the highest coefficient of correlation was calculated between the two indices, it can be seen from figure 13 that the two indices have relatively similar evolutions, the increasing trend of production attracting a similar trend of protein content.

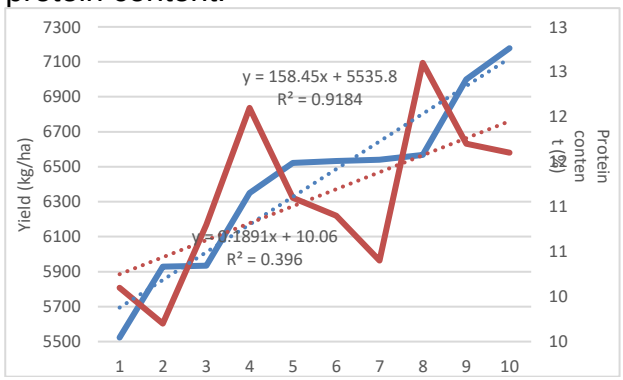


Figure 13. Variation in the evolution of protein content according to the increasing trend of grain production in 2021

In the year 2023, it can be seen from figure 14 that, against the background of an increasing trend of grain production, the protein content also has a sinusoidal evolution, a fact that determines, as in the year 2020, a very weak link between the two indices.

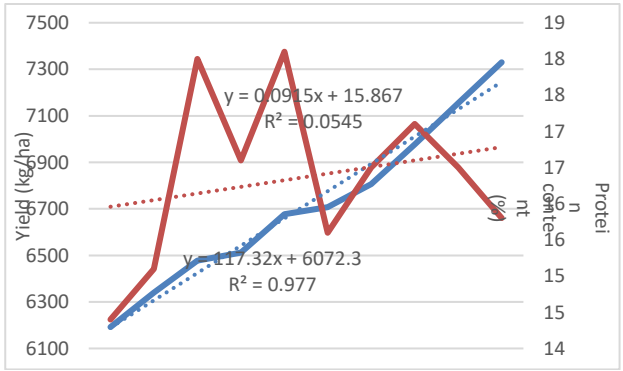


Figure 14. Variation in the evolution of protein content according to the increasing trend of grain production in 2023

As a result of this experiment, it can be concluded that the use of chemical or organic fertilizers can significantly influence both the production and the protein content of wheat. Fertilizers with high nitrogen content are associated with an increase in protein production and quality. Correct fertilization is essential to maximize wheat production and quality. The study showed that an adequate level of fertilization not only increases the amount harvested, but also improves the quality of protein. Nitrogen fertilization, in particular, plays a crucial role in grain protein development.

Weather conditions such as rainfall and temperature interact with fertilization effects. Thus, adequate rainfall can amplify the positive effects of fertilization on wheat yield and quality.

Yield capacity is a complex quantitative character determined by many components and also influenced by environment factors while grain quality is an essential element of the entire value chain to produce a quality product, store, process and eventually supply it to the consumer's use (Iancu Paula and Soare, M., 2017).

CONCLUSIONS

The 10 varieties tested in the years 2020-2023 at SCDA Șimnic behaved differently both in terms of production and its quality.

Effective fertilization management can lead to significant improvement in wheat quality, by increasing both yield and protein content. These aspects are essential for ensuring sustainable and quality harvests in contemporary agriculture.

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