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PRODUCTIVITY AND BAKING QUALITY OF AUTUMN WHEAT VARIETIES UNDER DIFFERENT TECHNOLOGICAL CONDITIONS ON THE CARACAL CHERNOZEM

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Abstract

Over a period of three years (2019-2022), 25 varieties of autumn wheat were studied at SCDA Caracal (University of Craiova), in terms of yield and its quality under different technological conditions (fertilization level and sowing time). Several aspects were addressed: the variability of the characters influencing quality and the way the applied technologies influence it; the productivity and baking quality of the tested wheat varieties, depending on the applied technologies; the stability of the studied characters for the tested wheat varieties; the ranking of the values of the studied characters expressed by a score-based ranking. The results showed that yield gain could be obtained by increasing the nitrogen dose and that the quality of the yield was significantly improved by delaying sowing. Increasing the nitrogen dose resulted in higher yields, protein content, wet gluten content, flour power and gluten index, all of which were statistically assured. The most stable character was found to be hectolitre mass, whereas yield was medium stable and the wet gluten content was unstable for all varieties tested. The highest ranked Romanian varieties were Dropia, Glosa and Șimnic 50.

Key words: *autumn wheat, hectolitre mass, protein content, technologies, yield, wet gluten content.*

INTRODUCTION

Worldwide, there are 220 million hectares growing bread wheat (*Triticum aestivum* L.), one of the most important crops and the staple food for a third of the world's population, and demand is growing (Filip et al., 2023; Paux et al., 2022).

With a productivity of more than 4t/ha, Romania is a very active player in European agribusiness, ranking 4th in the EU in terms of wheat area sown.

As wheat plays a special role in human nutrition, the analysis and monitoring of grain quality indicators is a basic trend towards a strategy to increase the productivity and quality of wheat crops.

Today, particular attention is being paid both to improving the quality of wheat and to introducing high-protein wheat varieties into production. Thus, wheat improvement programmes have as their main objectives the development of varieties with high production capacity, good or very good breadmaking quality, high degree of adaptability to the environment (tolerance and resistance to drought and frost), tolerance and good resistance to cryptogamic diseases (Crespo-Herrera et al., 2022; Paux et al., 2022; Poddar, 2021). Following improvement programs were created and selected new wheat varieties and hybrids with performance characteristics (Paunescu et al., 2016; 2021; 2023).

Combining conventional plant breeding techniques with molecular bioengineering is one of the most modern ways to ensure global food security (Bonciu et al., 2021; De Souza, 2022a; 2022b), and this is all the more beneficial as the demand for bread wheat is increasing.

Bread constitutes a significant energy source and provides protein and some essential micronutrients to a large population worldwide (Bazhan and Shafiei Sabet, 2022; Silow et al., 2016). The bread quality plays an essential role in people's health. Wheat provides gluten-rich proteins, carbohydrates, vitamins, minerals, and essential amino acids necessary for human health.

According to Guzmán et al. (2022), wheat quality is a complex concept subdivided into milling, processing, end-use and nutritional quality. The ability of a wheat variety to produce a specific food according to the consumers' preferences has a great importance. But worldwide, plant diseases are a significant constraint to the production for main crops, especially wheat, that stand between the rapidly expanding world population and starvation (Cotuna et al., 2022a; Paraschivu et al., 2022). To improve the potential of a crop and increase the profitability of wheat harvests, it is important to adopt solutions based on effective plant health improvement technologies. Damage caused by weeds, pests or various pathogens pose real threats to wheat farmers (Cotuna et al., 2022b; Cotuna et al., 2022c). Thus, due to the huge global importance of wheat, *Triticum* species have been the subject of many researches (Goutam et al., 2013; Păunescu et al., 2022; Rosculete et al., 2021; 2023; Qin et al., 2018; Woźniak and Rachoń, 2020).

Consumer and legislative requirements demand rapid methods of analysis and assessment of quality indicators for wheat crops. In order to increase the yield and productivity of wheat crops, as well as the quality of harvests, farmers can turn to wheat varieties that are more resistant to drought and various diseases. These varieties have good resistance to high temperatures, but also good tolerance to the main foliar diseases.

Before it can be used in the bread-making process, baker's wheat has to pass tests to confirm that it has the qualities needed to be used for this purpose. The main quality indicators that are analysed are mineral salt content, protein content, wet gluten content, gluten deformation index and dropping index.

Cropping technologies that do not meet the requirements of growing wheat, harvesting at an inappropriate time, improper handling of production, are all factors that decrease the baking quality of wheat (Bazhan and Shafiei Sabet, 2022; Kurek et al., 2015; Rinaldi et al., 2015).

The quality parameters of flour and dough may change depending on the harvest year (Woźniak and Rachoń, 2020). At high temperatures, starch accumulation can be up to 130 times faster, resulting in lower expression levels and activities of genes encoding certain enzymes involved in the sugar synthesis pathway (Dupont and Altenbach, 2003). Also, fertilization has a significant impact on the development of bread wheat's qualitative characteristics (Dreisigacker et al., 2020).

Management and planning for producing high-quality wheat, industrialization of the agricultural system, observance of the correct principles of wheat cropping and harvesting, and mandatory implementation of the wheat standard were suggested to improve the quality of wheat (Bazhan and Shafiei Sabet, 2022).

The qualitative wheat characteristics are conditioned by the expression of multiple genes, their complex interactions and the influence of the environment and external factors (Torbica and Mastilović, 2008). Over-expression of some allele in wheat genotypes was strongly correlated with enhanced dough quality (Cho et al., 2017).

Baking quality of wheat is mostly determined by its grain protein content (Kaur et al., 2016). Protein content is a significant parameter in wheat quality assessment and its relation with how wet gluten affects the quality of flour (Sharma et al., 2020). Protein content also gives wheat special properties, such as water absorption (Sapirstein et al., 2018), dough elasticity (Shewry et al., 2002), gas retention capacity, etc. (Schopf et al., 2021; Sharma et al., 2020). These factors influence a product's baking characteristics, such as loaf volume, crust color, crumb structure, and shelf life.

MATERIALS AND METHODS

From 2019 to 2022, at S.C.D.A. Caracal were located 2 two-factor experiments, as follows: experiment 1 with factor A - variety with 25 gradations (Romanian and foreign autumn wheat varieties) and factor B - fertilization level with 2 gradations (N16P80 and N100P80); experiment 2 with factor A - variety with 25 gradations (same varieties from the first experiment) and factor B - sowing time with 2 gradations (sowing date - mid-October and end of October).

The aim of the work was to study Romanian and foreign wheat varieties in terms of yield and its quality under different technological conditions (fertilization level and sowing time). Several aspects were addressed: the variability of the characters influencing quality and the way in which the applied technologies influence it; the productivity and baking quality of the tested wheat varieties, depending on the applied technologies; the stability of the studied characters in the tested wheat varieties; the ranking of the values of the studied characters expressed by a score-based ranking.

Field and laboratory determinations of yield and quality were carried out on each variety. The following were determined: yield (kg/ha), hectolitre mass (kg/hl), protein content (%), wet gluten content (%), flour power (10-4/joules/g) and gluten index (%).

The technology applied was the normal one for the Caracal chernozem (Table 1).

Table 1. Technology applied to the experiments on the Caracal chernozem

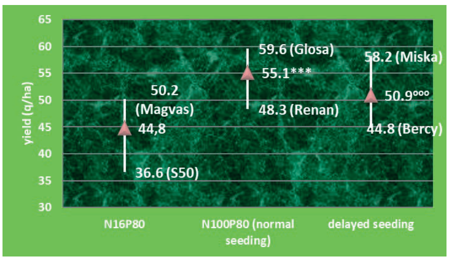
Technological work	Experiment 1		Experiment 2	
	N16P80	N100P80	Normal stage	Late stage
Pre-crop	Pea beans	Pea beans	Pea beans	Pea beans
Plowing + harrowing	Tractor 100 HP + PP3 plow + harrow (August)	Tractor 100 HP + PP3 plow + harrow (August)	Tractor 100 HP + PP3 plow + harrow (August)	Tractor 100 HP + PP3 plow + harrow (August)
Fertilized with NPK complex fertilizers	Tractor 100 HP + MA 6 (October)	Tractor 100 HP + MA 6 (October)	Tractor 100 HP +MA 6 (October)	Tractor 100 HP + MA 6 (October)
Disc work	Tractor 100 HP + GD 3 (October)	Tractor 100 HP + GD 3 (October)	Tractor 100 HP + GD 3 (October)	Tractor 100 HP + GD 3 (October)
Combinator work	Tractor 100 HP + comb. (October)	Tractor 100 HP + comb. (October)	Tractor 100 HP + comb. (October)	Tractor 100 HP + comb. (October)
Seed treatment	REDIGO PRO – 0.5 l/ha (October)	REDIGO PRO – 0.5 l/ha (October)	REDIGO PRO – 0.5 l/ha (October)	REDIGO PRO – 0.5 l/ha (October)
Sowing: 550 g.g/m^2	Plot drill (l=1.5 m) (10-15 oct)	Plot drill (l=1.5 m) (10-15 oct)	Plot drill (l=1.5 m) (10-15 oct)	Plot drill (l=1.5 m) (23-30 oct)
Fertilized with ammonium nitrate 250 kg/ha		Tractor 100 HP+MA 6 (March)	Tractor 100 HP+MA 6 (March)	Tractor 100 HP+MA 6 (March)
Spraying with fungicide and insecticide	ELATUS ERA 1 l/ha + KARATE ZEON 0.15 l/ha	ELATUS ERA 1 l/ha + KARATE ZEON 0.15 l/ha	ELATUS ERA 1 l/ha + KARATE ZEON 0.15 l/ha	ELATUS ERA 1 l/ha + KARATE ZEON 0.15 l/ha
Herbicide application	Tractor 100 HP + MET MUSTANG – 0.5 l/ha (April)	Tractor 100 HP + MET MUSTANG – 0.5 l/ha (April)	Tractor 100 HP + MET MUSTANG – 0.5 l/ha (April)	Tractor 100 HP + MET MUSTANG – 0.5 l/ha (April)
Harvesting	Plot combine (l= 1.5 m) (July)	Plot combine (l= 1.5 m) (July)	Plot combine (l= 1.5 m) (July)	Plot combine (l= 1.5 m) (July)
Weighing and conditioned of grain production	In the laboratory (July)	In the laboratory (July)	In the laboratory (July)	In the laboratory (July)

Changes were made to the level of fertilisation (one variant of factor B was fertilised only in autumn with NPK complex type 8-40-0 and the other was additionally fertilised with ammonium nitrate 250 kg/ha in spring) and to the sowing time (two sowing times spaced two weeks apart).
In all years of the experiment, rainfall was above average and the month of October provided very good conditions for crop establishment, with the exception of 2022.
We calculated: arithmetic mean, standard deviation, coefficients of variability for each technological condition but also for each trait recorded by each variety tested, limit differences by analysis of variance, amplitudes of the traits tested, correlations between traits for each technological condition experimented, ranking score, intra- and inter-stability.

RESULTS AND DISCUSSIONS

Yield

Fertilizing with higher nitrogen in spring resulted in a yield increase of 10.3 q/ha - a very significant increase, while delaying sowing resulted in a very significant decrease. None of the varieties stood out under the technological conditions applied, but the highest yield was obtained by Glosa - 59.6 q/ha in the variant fertilized with N100P80 and sown at the normal time (Figure 1).



DL 5% = 2.6 q/ha; DL 1% = 3.5 q/ha; DL 0.1% = 4.5 q/ha
DL 5% = 2.4 q/ha; DL 1% = 3.2 q/ha; DL 0.1% = 4.2 q/ha

Figure 1. The extent of yield and the influence of the studied technological conditions on it

The top of the distribution was found in different classes for each of the B-factor gradations (N16P80 fertilization - 40% in the 44-48 q/ha class; N100P80 fertilization and normal sowing time - 40%+40% in the 52-56 q/ha and 56-60 q/ha classes and late sowing time - 56% in the 48-52 q/ha class), which reinforces the fact that yield was influenced by both fertilization level and sowing time (Figure 2).

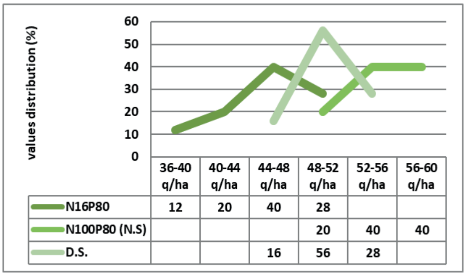


Figure 2. The distribution of yield values according to the technological conditions studied

Although the distribution of values was well particularized for each differentiated technology applied, the varieties tested were stable in terms of yield, the variability being less than 10%, but for the experiment as a whole, since the range of yields ranged from 36.6 to 59.6 q/ha, the variability was average (Table 2).

Table 2. Type of yield variability depending on the studied factors

Sample	Coefficient of variability (%)	Type of variation
N16P80	8.43	under 10% = low
N100P80 (normal stage)	6.00	under 10% = low
Late stage	6.19	under 10% = low
Total experiment	10.76	between 10 and 20% = average

All tested wheat varieties obtained statistically assured yield increases when the nitrogen dose was increased, suggesting that these varieties efficiently exploit nitrogen under the conditions at Caracal.
These varieties were observed to be productive at both fertilization levels: Alex, Apache, Pobeda, Renesansa, Cezanne, Marshall and Elet. The coefficient of determination shows that the variability of production at low nitrogen levels determines 32% of the variability of production when the nitrogen level is increased (Figure 3).

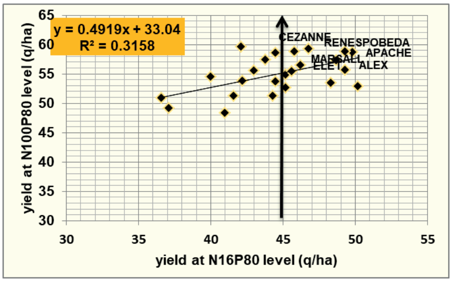


Figure 3. Relationship between yield at fertilization level N16P80 and yield at fertilization level N100P80

Under delayed sowing conditions, the Romanian varieties Glosa and Gruia stood out as productive regardless of sowing date. The coefficient of determination showed that the variability of yield at normal stage influenced 37% of the variability of yield when sowing was delayed (Figure 4).

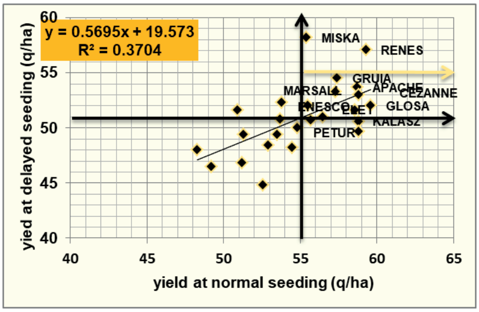
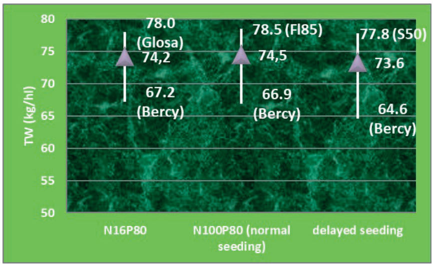


Figure 4. Relationship between normal-stage and late-stage yield

Hectolitre mass

The hectolitre mass of wheat for breadmaking according to the requirements must be more than 75 kg/hl and is considered very good when the MH is more than 78 kg/hl (Tabără et al., 2008).

Average MH values were not impacted by the fertilization level but were influenced by the sowing times, the decrease being distinctly significant. It can be seen that regardless of the technological condition, the Romanian varieties obtained the highest values of hectolitre mass, while at the opposite pole was the variety Bercy, constantly ranked last (Figure 5).



DL 5% = 0.8 kg/hl; DL 1% = 1.1 kg/hl; DL 0.1% = 1.5 kg/hl

DL 5% = 1.0 kg/hl; DL 1% = 1.3 kg/hl; DL 0.1% = 1.7 kg/hl

Figure 5. Amplitude of hectolitre mass and influence of studied technological conditions on it

For the conditions at Caracal, MH is a stable trait, with the maximum distribution of values in the same class for all the tested varieties (75.1-77 kg/hl), as follows: 32% for the N16P80 variety; 36% for the N100P80 variety and sown at normal sstage; 32% at late stage (Figure 6).

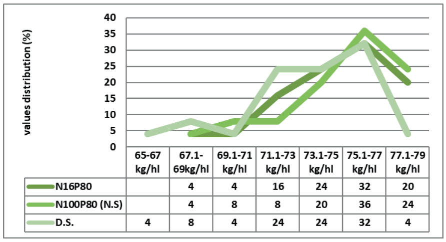


Figure 6. Distribution of hectolitre mass values according to the studied technological conditions

The hectolitre mass is a stable characteristic, regardless of fertilization level and sowing time (Table 3).

Table 3. Type of variability of hectolitre mass depending on the studied factors

Sample	Coefficient of variability (%)	Type of variation
N16P80	3.52	under 10% = low
N100P80 (normal stage)	3.76	under 10% = low
Late stage	3.86	under 10% = low
Total experiment	3.76	under 10% = low

The coefficient of determination of the relationship shown below (Figure 7) is a measure of how much variables vary together. In this case, it means that they vary together for 95% on their variation. The Romanian varieties are clearly highlighted, the only ones to obtain high values at both fertilisation levels.

A grouping of the MH values according to the scale (above 78 kg/hl - very good quality; 75-78 kg/hl - good quality; 70-75 kg/hl - satisfactory quality; below 70 kg/hl - unsatisfactory quality) classifies the tested varieties as follows: varieties with very good quality at both fertilization levels - Fl 85; varieties with good quality at N16P80 and very good at N100P80 - Dropia and Șimnic 50; varieties with good quality at both fertilization levels - Boema, Glosa, Alex, Serina, Palma, Pobeda, Renesansa, Gruia, Miska, Marsall, Palma; varieties with satisfactory quality at N16P80 and good quality at N100P80 - Enesco, Renan, Elet, Gobe; varieties with satisfactory quality at both fertilisation levels - Exotic, Apache, Othalom, Petur, Magvas; varieties with unsatisfactory quality at N16P80 and satisfactory at N100P80 - Cezanne; varieties with unsatisfactory quality at both fertilization levels - Bercy. It can be seen that foreign varieties are mainly placed in the lower classes in terms of quality expressed by this characteristic.

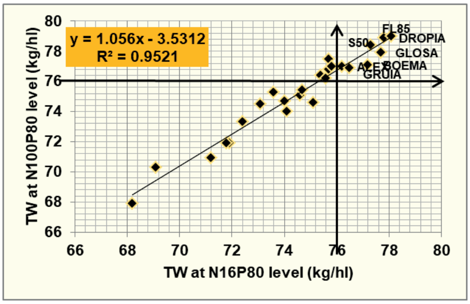


Figure 7. Relationship between hectolitre mass at fertilization level N16P80 and hectolitre mass at fertilization level N100P80

Also at the sowing stage, 93% of the variability of one variable is matched by variability of the other variable (Figure 8).

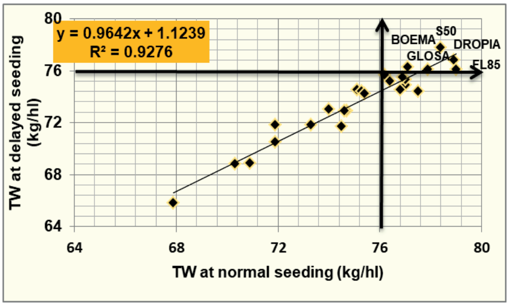


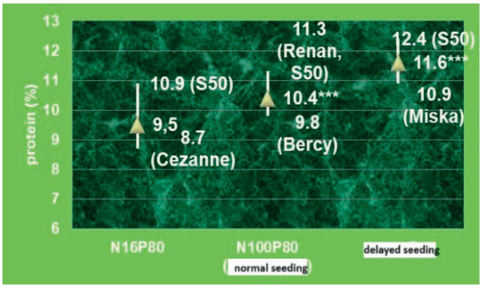
Figure 8. Relationship between hectolitre mass at normal stage and hectolitre mass at late stage

After classifying the results according to the scale, the following variety categories are distinguished: varieties with very good quality at normal sowing time and good at late sowing time - Dropia, Fl 85 and Șimnic 50; varieties with good quality at both sowing times - Boema, Glosa, Serina, Pobeda, Renesansa, and Gruia; varieties with good quality at normal sowing time and satisfactory at late sowing time -Alex, Marsall, Palma, and Renan; varieties of satisfactory quality at both sowing times - Exotic, Apache, Enesco, Gobe, Kalasz, Miska, Othalom, Petur, and Magvas; varieties of satisfactory quality at normal sowing time and unsatisfactory at late sowing time - Cezanne and Elet; varieties of unsatisfactory quality at both sowing times - Bercy.

All varieties recorded lower values when sowing was delayed but only half of them had these decreases statistically assured: Dropia, Fl 85, Glosa, Alex, Apache, Bercy, Cezanne, Elet, Gobe, Miska, Petur, Marsall and Pobeda.

Protein content

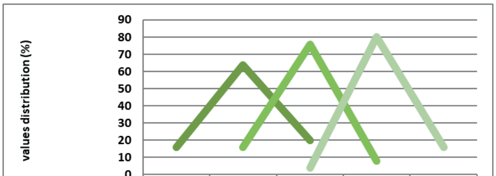
The variety Simnic 50 stood out, which, irrespective of the variant, obtained the highest values among the 25 varieties tested. When increasing the nitrogen dose a very significant increase in protein content was observed, but it should be noted that on average the values were below the uptake limit - 10.5%. Delayed sowing resulted in an even more pronounced increase in protein content (Figure 9).



DL 5% = 0.4 %; DL 1% = 0.5 %; DL 0.1% = 0.7 %
DL 5% = 0.4 %; DL 1% = 0.6 %; DL 0.1% = 0.7 %

Figure 9. Amplitude of protein content and influence of studied technological conditions on it

The common range of the three technological conditions is practically only one value - 10.9 %, which denotes a strict delimitation of the results according to the gradation of factor B. Moreover, the top of the distribution is also found in another class for each of the technological conditions (N16P80 fertilized variant - 64% in class 9.1-10%; N80P100 fertilized and normal-stage variant -76% in class 10.1-11%; late-stage variant -80% in class 11.1-12%) (Figure 10).
Protein content is a stable trait regardless of fertilization level and sowing time, indicating that it is mainly a genetically determined trait and that the variety with superior baking quality is the same under all technological conditions (Table 4). Even if the variety has an improved quality by increasing the nitrogen dose, compared to other varieties tested it maintains its position.



	8-9%	9.1-10%	10.1-11 %	11.1-12 %	12.1-13%
N16P80	16	64	20		
N100P80 (N.S)		16	76	8	
D.S.			4	80	16

Figure 10. Distribution of protein content values according to the studied technological conditions

In the case of protein content, the coefficient of determination of the relationship presented below shows a fairly high interdependence (66%) of the variability of protein content in wheat sown at normal stage and the variability of protein content in wheat sown at late stage (Figure 11).

Table 4. Type of variability of protein content according to the studied factors

Sample	Coefficient of variability (%)	Type of variation
N16P80	5.87	under 10% = low
N100P80 (normal stage)	3.93	under 10% = low
Late stage	3.36	under 10% = low
Total experiment	9.12	under 10% = low

The ranking of the results according to the minimum uptake limit showed that over 10.5% in both fertilization conditions were recorded by the varieties Dropia, Fl 85 and Şimnic 50 and the minimum 10.5% was only shown by the varieties Boema, Exotic, Enesco, Marsall, Palma, Renan, Renesansa and Gruia in the variety fertilized with N100P80.

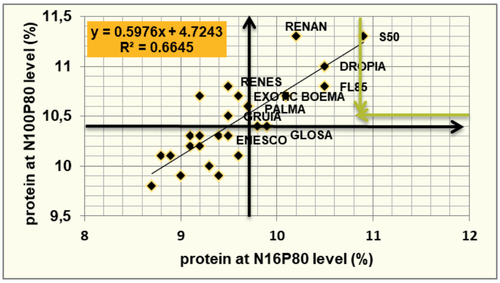


Figure 11. Relationship between protein content at fertilization level N16P80 and protein content at fertilization level N100P80

If we rank the results according to the minimum uptake limit, we have two categories of varieties: varieties with minimum uptake under both sowing conditions: Dropia, Fl 85, Boema, Exotic, Marsall, Palma, Renan, Renesansa, Gruia and Şimnic 50; varieties which record a minimum of 10.5% protein only for the variety sown at late stage: Glosa, Alex, Apache, Bercy, Cezanne, Enesco, Elet, Gobe, Kalasz, Miska, Othalom, Petur, Serina, Magvas and Pobeda (Figure 12).

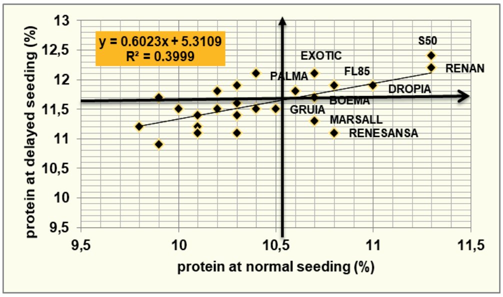
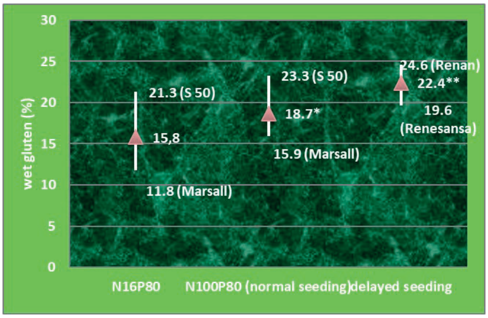


Figure 12. Relationship between protein content at normal stage and protein content at late stage

Wet gluten content was influenced by both fertilization level and sowing time. Again, Simnic 50 stood out for its registered high values (Figure 13).
The composition and proportions of individual gluten fractions are the main determinants of the rheological properties of dough, which, in turn, indicate the quality of given wheat (Filip et al., 2023).



DL 5% = 2.5 %; DL 1% = 3.3 %; DL 0.1% = 4.3 %
DL 5% = 2.7 %; DL 1% = 3.6 %; DL 0.1% = 4.6 %

Figure 13. Amplitude of wet gluten content and influence of studied technological conditions on it

The maximum distribution of values according to the fertilization level is concentrated in the same class 16-18.9% while for the differentiated sowing periods, at normal stage it is in the class 16-18.9% (48% of the values) and at late stage in a higher class 22-24.9% (68% of the values). Particularly noteworthy for the late sowing season: all the values were essentially within 2 classes (Figure 14). The coefficient of variability also showed this with the recorded value (Table 5).

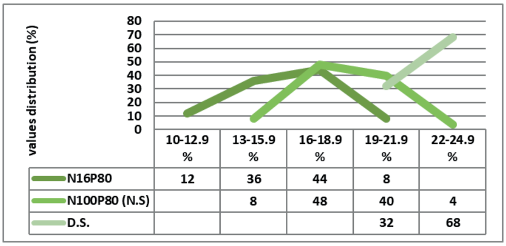


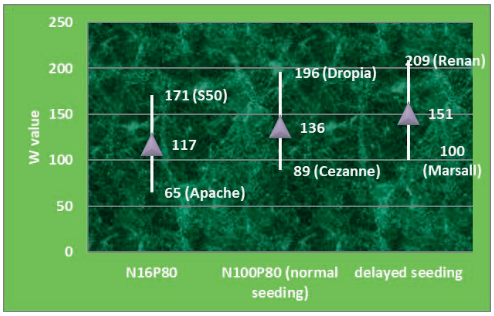
Figure 14. Distribution of wet gluten content values according to the studied technological conditions

Table 5. Type of variability of wet gluten content depending on the studied factors

Sample	Coefficient of variability (%)	Type of variation
N16P80	14.68	between 10 and 20% = average
N100P80 (normal stage)	10.38	between 10 and 20% = average
Late stage	5.36	under 10% = low
Total experiment	17.35	between 10 and 20% = average

Flour strength

A distinctly significant increase in flour strength was only observed when the nitrogen dose was increased (Figure 15). The N16P80-fertilized and N100P80-fertilized variants have only two common classes (101-150 and 151-200 joules) and concentration of values in differentiated classes (44% of values in the 50-100 joules class for the first variant and 52% of values in the 101-150 joules class). The normal and late sowing stages have three common classes (101-150, 151-200 and 201-250 joules) and also concentration of values in differentiated classes (101-150 joules - 52% of normal stage values and 151-200 joules - 44% of late stage values) (Figure 16). In general, the strength of the flour fluctuated widely over a wide range (50-250 joules), thus the variability recorded was high (Table 6).



DL 5% = 23 jouli; DL 1% = 31 jouli; DL 0.1% = 40 jouli
DL 5% = 29 jouli; DL 1% = 40 jouli; DL 0.1% = 52 jouli

Figure 15. Amplitude of flour strength and influence of studied technological conditions on it

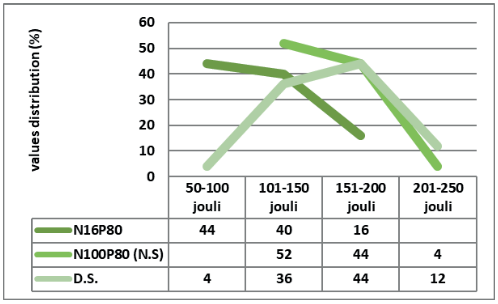


Figure 16. Distribution of wet gluten content values according to the studied technological conditions

Table 6. Type of variability of flour strength depending on the studied factors

Sample	Coefficient of variability (%)	Type of variation
N16P80	23.55	over 20% = high
N100P80 (normal stage)	17.65	between 10 and 20 % = average
Late stage	19.34	between 10 and 20 % = average
Total experiment	23.78	over 20% = high

The varieties tested were divided as follows: varieties with breadmaking flour at fertilization level: N16P80 and fast-growing flour at N100P80 dose: Dropia, Fl 85, Glosa; varieties with breadmaking flour at both fertilization levels: Gruia, Ş 50, Pobeda; varieties with non-breadmaking flour when nitrogen dose is reduced and with breadmaking flour when nitrogen dose is increased: Boema, Exotic, Alex, Apache, Elet, Kalasz, Magvas, Pobeda, Renesansa; varieties with non-breadmaking flour at both fertilization levels: Bercy, Cezanne, Enesco, Gobe, Miska, Othalom, Petur, Serina, Marsall; varieties with non-breadmaking flour at N16P80 and fast-growing flour at N100P80: Renan (Figure 17).

Fast growing varieties at both sowing stages were highlighted: Dropia, Fl 85 and Renan (Figure 18).

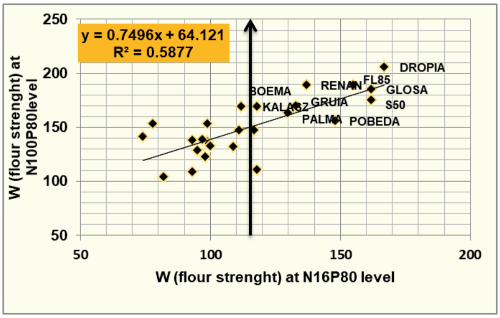


Figure 17. Relationship between flour strength at fertilization level N16P80 and flour strength at fertilization level N100P80

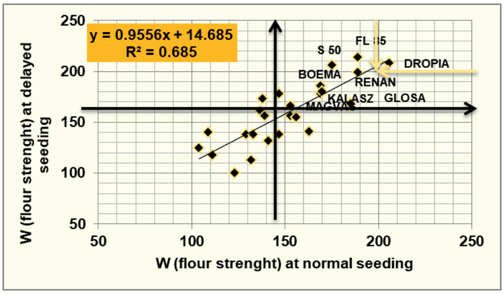
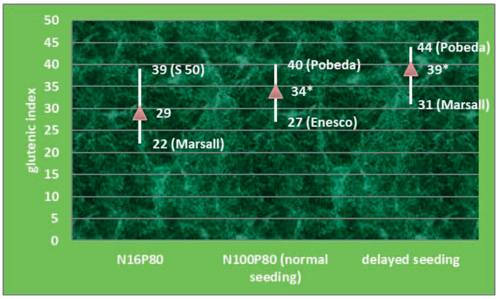


Figure 18. The relationship between flour strength at normal stage and flour strength at late stage

Gluten index increased significantly when nitrogen was increased and when sowing was delayed (Figure 19).

The maximum concentration of the values obtained was observed in different classes: 48% in class 26-30 for the N16P80 fertilized variety; 48% in class 31-35 for the N100P80 fertilized variety sown at normal stage; 64% in class 36-40 sown at late stage. When sowing was delayed, the varieties tested fell without exception in the classes with more than 31% gluten index and the peak of the distribution was predominantly in the 36-40% class (Figure 20). Under Caracal conditions, delayed sowing is recommended at the expense of sowing at normal stage.



DL 5% = 5 ; DL 1% = 7 ; DL 0.1% = 9
DL 5% = 5; DL 1% = 7; DL 0.1% = 9

Figure 19. Gluten index amplitude and influence of studied technological conditions on it

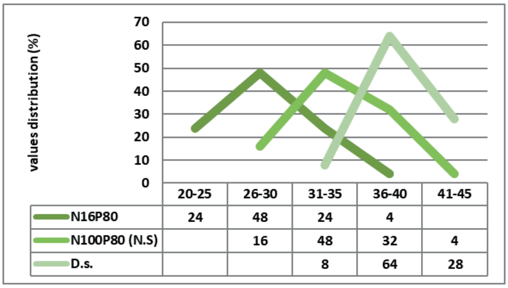


Figure 20. Distribution of gluten index values depending on the studied technological conditions

With the exception of the late stage, the stability of the characteristic was average (Table 7).

Table 7. Type of gluten index variability depending on the studied factors

Sample	Coefficient of variability (%)	Type of variation
N16P80	14.65	between 10 and 20% = average
N100P80 (normal stage)	10.18	between 10 and 20% = average
Late stage	7.06	under 10% = low
Total experiment	16.46	between 10 and 20% = average

According to the gluten index, the varieties were classified as follows: quality I (over 35%) at both sowing times: Dropia, Fl 85, Boema, Glosa, Exotic, Apache, Kalasz, Othalom, Pobeda, Renan, Renesansa, Gruia, Ş 50; quality II regardless of sowing time: Marsall; quality II at normal-stage sowing and quality I at late-stage sowing: Alex, Bercy, Cezanne, Enesco, Elet, Gobe, Miska, Petur, Serina, Magvas.

The summary presentation of the stability of the characteristics studied on the Caracal chernozem, showed that all the varieties tested recorded average stability for yield, high stability for hectoliter mass and instability of gluten content, flour strength and gluten index with the exception of the variety Şimnic 50 for all three characteristics and Glosa and Pobeda for the last one (Table 8).

Table 8. Synthesis of stability for the tested wheat varieties on the Caracal chernozem

Variety	Studied characteristics					
	PROD	MH	Pr	Gu	Ig	W
DROPIA	19.2	3.6	9.5	28.1	24.3	23.6
FL 85	17.1	3.25	9.66	26.9	34.6	21.9
BOEMA	13.8	2.04	11.6	31.5	40.8	35.5
GLOSA	17.68	2.85	11.99	20.5	41.5	15.9
EXOTIC	12.9	3.56	16.1	33.5	33.1	21.3
ALEX	11.85	2.71	14.45	37.3	27.6	27
APACHE	12.9	4	17	43.8	46.1	41.6
BERCY	17.9	4.5	17.6	36.6	59.7	28.1
CEZANNE	15.8	3.22	15.2	41.7	39.8	37.1
ENESCO	15.4	2.36	12.7	44.6	40.6	32.3
ELET	15.7	4.3	16	37.2	40.7	35.4
GOBE	16.8	2.1	70.1	31.7	31.5	26.8
KALASZ	14.1	2.89	10.1	44.4	49	32.8
MISKA	14.1	3.2	13.6	42.5	40	42
OTHALOM	10.9	3	14.9	34.3	31.4	32.8
PETUR	16.4	2.3	13.6	29.2	27	31.3
SERINA	16.6	2.3	16.1	41.1	41	35.8
MAGVAS	17	2.3	17.5	49.5	45.8	35.7
MARSALL	12.1	2.2	15.9	36.2	46.7	39.5
PALMA	15.8	3.2	16	37.4	32.3	32
POBEDA	14.8	2.7	13.8	27.2	27.2	16.9
RENAN	18.8	3.2	14.1	27.4	23.6	26.3
RENESANSA	13.3	2	13.7	29.8	25.1	33
GRUIA	18.6	5.5	11.8	32	29.8	28.6
ŞIMNIC 50	18.3	2.3	9.1	17.1	18.6	14.7

CONCLUSIONS

Yield increases can be obtained by increasing the nitrogen dose and the quality of production is significantly improved by delaying sowing.

Increasing the nitrogen dose was reflected in increases in flour strength and the gluten index, both statistically assured. On the other hand, delayed sowing resulted in an increase in the gluten index, also statistically assured.

Romanian varieties performed best, with Glosa, Dropia and Șimnic 50 standing out. Among the foreign varieties we recommend growing the Pobeda variety.

Among the varieties tested, we do not recommend growing Bercy, Cezanne and Enesco under the climatic conditions of Caracal.

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