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RESEARCH ON THE INFLUENCE OF FOLIAR FERTILIZER TREATMENT ON THE YIELD OF DIFFERENT WINTER WHEAT VARIETIES DEPENDING ON WATER SUPPLY LEVELS, ON CHERNOZEM

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Abstract

In 2023 and 2024, on the chernozem of Caracal, a three-factorial experiment with wheat was located for study the influence of the variety, foliar fertilizer treatment, water supply level and their interaction on yield, test weight and protein content. The yield and test weight were influenced by the variety and the level of water supply. Protein content was influenced only by the variety. The lowest yield was recorded by the Glosa variety fertilized with Foliq Nitrogen (3 kg/ha) sown under non-irrigation conditions – 5233 kg/ha and the highest was 7289 kg/ha for the Gabrio variety fertilized with Foliq Nitrogen (5 kg/ha) sown under irrigation conditions with a norm of 50% of the active moisture interval (AMI). The thousand weight grains had the highest value in the Glosa variety fertilized with Foliq Cereale (1 l/ha). The protein content values ranged between 10.52% (Avenue variety fertilized with Foliq 36 N 3 l/ha and irrigated at the level of 50% of the AMI) and 12.36% (Glosa variety fertilized with Foliq Cereale 2 l/ha and irrigated at the level of 50% of the AMI).

***Key words**: wheat, foliar fertilizer, water supply level, yield, protein.*

INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important agricultural crops with a wide area of distribution, grown worldwide in more than one hundred countries, providing about 20% of the caloric and protein requirements for the human diet (Guarin et al., 2022).
World wheat production is growing steadily, according to statistics registering about 808 Mt in 2022, but to meet the estimated global cereal demand by 2050, wheat production needs to be continuously improved and this even in the context of climate change (del Pozo et al., 2016). A study (Van Dijk et al., 2021) suggested that cereal production would need to be increased by 35-56% to meet global food demand by 2050, respectively by 30-62% when accounting for climate change.
The soil and climatic conditions associated with the applied technology are decisive factors in the success of wheat cultivation, both in terms of productivity and quantity (Sobolewska et al., 2020; Rebouh et al., 2023).
Drought is a severe source of abiotic stress that threatens wheat (*Triticum aestivum* L.) growth and yield worldwide and is exacerbated by climate change (Wang et al., 2016; Zhang et al., 2017; Alam et al., 2020).
Wheat is one of the most adaptable crops under different environmental conditions, with very wide ecological plasticity, benefiting from efficient biological mechanisms in adapting to soil and climatic conditions (Stoian et al., 2015; Bărdaș et al., 2024).
The choice of varieties depends on the area, while soil and foliar applications of macro- and micronutrients contribute to adequate plant nutrition (Bielski et al., 2020; Wojtkowiak et al., 2015).
In order to produce more high-quality wheat, it is important to not only breed innovative high-quality varieties but also adopt optimized farming practices, such as improved water

management (Buster et al., 2022; Si Z. et al., 2023), as well as new fertilization methods. Severe water scarcity and uneven rainfall distribution have become major challenges for meeting the growth needs of fall wheat, and supplemental irrigation is thus urgent for production (Jiatun et al., 2020; Motazedian et al., 2019).

Understanding the mechanism regulating the physiological process of wheat under different irrigation regimes will provide the theoretical basis for optimizing water-saving irrigation technology for sustainable wheat production. The adjustment of irrigation water is based on the regulation of the water demand of wheat during growth periods, a mild water deficit in vegetative stages causes the transpiration rate to decrease while the photosynthesis rate remains unchanged. Besides, winter wheat is highly resistant to moderate water stress in early vegetative growth periods and many negative effects can be eliminated after rehydration, such as photosynthesis and transpiration rates can quickly recover, or even exceed, which does not affect the accumulation of dry matter in the later periods of wheat (Si Z. et al., 2023).

In search for high yield, nitrogen fertilizers applied by farmers far exceed crop demand (Zhang et al., 2015). Excessive fertilization can lead to soil degradation and groundwater pollution (Yan et al., 2021). Previous studies have indicated that adequate soil moisture promoted the availability N capacity and simultaneous water use (Li et al., 2019; Di Paolo & Rinaldi, 2008). Therefore, there is a pressing demand for synergistic improvement of irrigation and fertilization synergy for wheat production in arid and semi-arid regions (Shicheng et al., 2021).

Fertilizer management is an important part of crop production, and proper application is considered a key component of achieving high yields and quality. Research in this regard demonstrates that, compared to soil application, foliar nitrogen fertilizer foliar application improves plant mineral nutrient content, increases productivity, quality and yield components of wheat and yield components of wheat (Arif et al., 2006; Tea et al., 2004; Baloch et al., 2019).

Among several advantages, foliar fertilization is able to alleviate nutrient deficiency faster than soil application (Fageria et al., 2009; Niu et al., 2021). In common wheat (*Triticum aestivum* L.), the application of nitrogen through foliar spraying is recognized as one of the most efficient agronomic tools to improve the grain protein content and the bread-making properties of flours (Bly et al., 2003; Arif et al., 2006; Ferrari et al., 2021). However, wheat response depends on the form of fertilizer, concentration and frequency of application, growth stage and leaf age, and other morphological and physiological traits (Fernández et al., 2013).

As N is allocated faster to grains through leaf application (Wuest & Cassman, 1992), the practice of applying N solutions to the canopy is commonly used only late in the growing season, particularly at anthesis (Wyatt et al., 2017; Ransom et al., 2016; Wuest & Cassman, 1992) or early milk (Turley et al., 2001), with the aim of improving flour quality and the bread-making properties (Rossmann et al., 2019; Ferrari et al., 2021).

Given the importance of fertilization in the success of any crop and the introduction on the market of numerous fertilizer products, many of which are foliar applied, the purpose of this paper is to present the yield and quality results obtained from experiments with two types of foliar fertilizers applied at different rates and at different times to three varieties of autumn wheat under different water supply conditions.

MATERIALS AND METHODS

The aim of the study is to determine the influence of foliar fertilizer application on the yield and quality of wheat crop depending on the variety and the optimal time of application through the level of soil water supply on the Caracal chernozem.

The study involves the influence of the studied factors (factor A - variety with 3 gradations - Glosa, Avenue, Gabrio; factor B - foliar fertilizer with 5 gradations; untreated, Foliq 36 Nitrogen 3 L/ha, Foliq 36 Nitrogen 5 L/ha; Foliq Cereal 1 L/ha, Foliq Cereal 2 L/ha; factor C - water supply level with 3 gradations: non-irrigated, irrigated at 50% of AMI and irrigated at 75% of IUA) and their interaction (variety x foliar fertilizer x level of water supply) on yield, 1000-grain mass and protein content (estimated by NIR- Near Infrared Spectroscopy).

A trifactorial experiment in 3 replications was located in Caracal in the autumn of 2022. Seed from 3 varieties of autumn wheat and 2 types of foliar fertilizer were used.

The *Glosa* variety, approved in 2005, was obtained at INCDA Fundulea from the complex hybrid combination Delabrad"S"/Dor"S"// Bucur, through individual selection. In the last decade, *Glosa* has been cultivated in 30 - 37% of the country's area, enjoying great success among farmers in all parts of the country, with very high adaptability and superior yield potential compared to previous varieties.

Avenue variety, an extra-early variety, the most sold wheat variety with foreign genetics in Romania, implicitly in the area of influence of SCDA Caracal. Very good yield potential. Recommended for cultivation in all growing areas, but especially in the south and south-east of Romania because it reaches flowering before the onset of very high temperatures.

The *Gabrio* variety is an early variety with a well-developed ear and a rustic appearance. It has high yield potential, medium intensive. High productivity and quality indices due to adaptability to different climatic and technological conditions. High protein content of superior quality.

Foliar fertilizers: 2 types in 2 different doses.

FOLIQ 36 NITROGEN**:** Content 36% N + 4% MgO + microelements (Table 1).

Table 1. Macro and micro elements content of FOLIQ 36 NITROGEN foliar fertilizer

Macro and micro elements	% of weight	% of volume
Total nitrogen (N)	27	36
Nitric nitrogen (NO_3^--N)	5	24
Ammoniacal nitrogen (NH_4^+-N)	4	5
Urea nitrogen (N)	18	7
Magnesium (MgO)	3	4
Boron (B)	0.010	0.012
Copper (Cu)	0.007	0.008
Iron (Fe)	0.020	0.027
Manganese (Mn)	0.013	0.015
Molybdenum (Mo)	0.001	0.001
Zinc (Zn)	0.005	0.006

It is recommended for crop fertilization obtaining high productivity. Application of the product speeds up the regeneration of crops damaged during winter or with phytotoxicity caused by pesticides. Applied when the plants are young, it stimulates growth during periods when nutrient uptake is limited because the root system is underdeveloped**.**

FOLIQ CEREALS: Content 12% N + 15%K_2O + 4%MgO +7 %SO_3 + microelements (Table 2). It is a foliar applied fertilizer with a formulation specially designed to prevent and treat microelements deficiency in the plant. Its composition largely meets the nutritional needs of intensive crops, ensuring their proper development throughout the growing season, favouring high and stable yields and optimal development before the onset of winter to better withstand frost.

These foliar were applied over a base fertilization with NPK 20-20-20-0 in autumn 250 kg/ha and 250 kg/ha ammonium nitrate, with 33.4% N.

Table 2. Macro and micro elements content of FOLIQ CEREAL foliar fertilizer

Macro and micro elements	% of weight	% of volume
Total nitrogen (N)	8	12
Urea nitrogen (N)	4	6
Ammonia nitrogen (NH_4^+-N)	4	6
Potassium (K_2O)	10	15
Magnesium (MgO)	3	4
Sulphur (SO_3)	5	7
Boron (B)	0.3000	0.435
Copper (Cu)	0.5000	0.725
Iron (Fe)	1.0	1.450
Manganese (Mn)	1.5	2.175
Molybdenum (Mo)	0.0100	0.015
Zinc (Zn)	1.0	1.450

Water supply level

Watering was applied with a perforated PVC pipe system, which ensures a good distribution of water on the plot. The water applied was measured with a flow meter. Soil moisture was determined by means of tensiometers, which were placed at different intervals along the watering depth.

The statistical processing of the experiment was carried out with the statistical analysis program specific for trifactorial experiments based on the methodology presented by N. Săulescu (PSUB 3) (Săulescu & Săulescu, 1967). The influence of the studied factors (variety, foliar fertilizer, water supply level) and the interaction of variety x foliar fertilizer x water supply level on yield, hectolitre mass, 1000-grain mass and protein content was interpreted.

Boxplot (Hawkins, 2009) was used to present the distribution of yield values.

Climatic conditions were different from year to year (Table 3 and 4). Thus, while 2023 was a favourable year for the crop, with rainy April and May months against a background of cooler than normal temperatures, 2024 was a rainfall deficit year but with a more differentiated month than all the others in the growing season, which also saved wheat production.

Table 3. The evolution of the main climatic factors during the growing season of straw cereals genotypes at S.C.D.A. Caracal, in the agricultural year 2022-2023

Specification		X	XI	XII	I	II	III	IV	V	VI	Total period
Temperature °C	Monthly minimum	-0.7	-2.7	-4.5	-3.1	-9.8	-7.5	-0.5	5.5	11.0	
	Monthly maximum	27.2	27.3	14.5	19.9	22.9	20.7	22.0	27.8	37.6	
	Monthly average	13.7	8,7	2,8	4,0	3.6	7.7	10.7	15.0	21.4	
	NORMAL	11,7	5,1	0.3	-1.3	0.8	6	12	17.7	21,6	
	Difference ±	+2.0	+3.6	+2.5	+5.3	+2.8	+1.7	-1.3	-2.7	-0.2	
Precipi-tations mm	Total monthly	15.0	78.8	33.8	103.4	13.2	20.8	68.8	78.6	44.4	456.8
	Multiannual average	46.0	37.0	39.1	30.8	26.3	34.2	47.8	58.6	69.7	389.5
	Difference±	-31.0	+31.8	-5,3	+72.6	-13.1	-13.4	+21.0	+20.0	-25.3	+67.3
Relative humidity of air %	Average	75.5	93.0	97.8	96.5	86.0	79.2	84.2	80.5	80.6	

Table 4. The evolution of the main climatic factors during the growing season of straw cereals genotypes at S.C.D.A. CARACAL, in the agricultural year 2023-2024

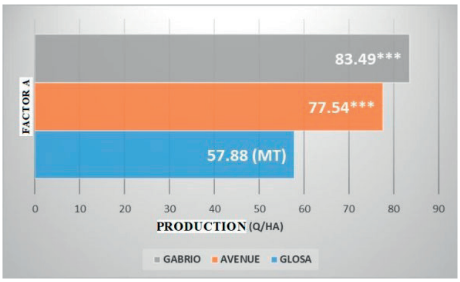
Specification		X	XI	XII	I	II	III	IV	V	VI	Total period
Temperature °C	Monthly minimum	0.6	-4.4	-3.2	-9.6	-6.7	-3.3	2,0	5.4	12.5	
	Monthly maximum	33.4	21.4	18.2	15.3	21.9	28.3	32,7	30.8	39.4	
	Monthly average	16.0	8.1	3.9	1.0	8.0	8.9	15,0	17.2	25.9	
	NORMAL	11.7	5.1	0.3	-1,3	0.8	6.0	12,0	17.7	21.6	
	Difference ±	+4.3	+3.0	+3.6	+2.3	+7.2	+3.9	+3,0	-0.5	+4.3	
Precipi-tations mm	Total monthly	21.4	124.2	21.4	26.8	11.6	22.4	26,0	71,8	31.6	357.2
	Multiannual average	46.0	37.0	39.1	30.8	26.3	34.2	47,8	58.6	69.7	389.5
	Difference±	-24.6	+87.2	-17.7	-4.0	-14.7	-11.8	-21,8	+13.2	-38.1	-32.3
Relative humidity of air %	Average	66.9	91.1	93.8	95.4	84.7	85.3	70,8	77.8	61.3	

RESULTS AND DISCUSSIONS

On average over the two years of testing, the influence of variety on yield was emphasized, mainly due to the strong attack of yellow rust on Glosa in 2023.

Avenue and Gabrio yields were significantly higher than the control - Glosa, with substantial differences (+19.66 q/ha and +25.61 q/ha, respectively) (Figure 1).

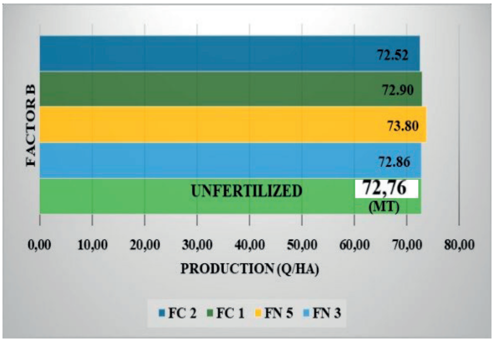
In addition, the rainfall in May, exactly at the grain filling phenotype, coupled with lower than normal temperatures, greatly helped the foreign varieties by creating a microclimate conducive to maximizing their productive capacity.



DL 5% = 1.89 q/ha; DL 1% = 3.13 q/ha; DL 0.1% = 5.84 q/ha

Figure 1. The influence of variety (factor A) on wheat yield - Caracal 2023-2024

On the other hand, fertilization with foliar fertilizer, irrespective of the product and the dose applied, did not show any significant differences in relation to the non-fertilized variant, and therefore did not show any influence on the yield obtained (Figure 2). As differences were not statistically assured, all variants were at the control level.



DL 5% = 1.94 q/ha; DL 1% = 2.63 q/ha; DL 0.1% = 3.52 q/ha

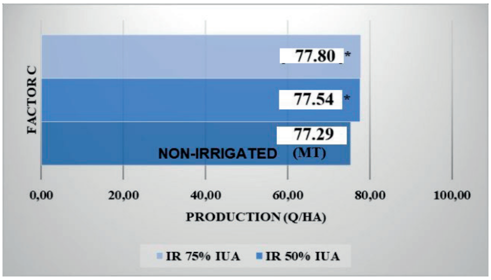
Figure 2. Influence of foliar fertilizer (factor B) on wheat yield - Caracal 2023-2024

Water supply at 50% of the IUA and 75% of the IUA boosted yields significantly, with an increase of 2.25 q/ha for the first level and 2.51 q/ha for the second level (Figure 3).

On average, the highest yield was recorded by Gabrio variety fertilized with maximum Foliq 36 N and irrigated at 50% of IUA - 87.87 q/ha.

The three-factor interaction of variety (factor A) x foliar fertilizer (factor B) x irrigation water supply (factor C) greatly influences yield. In all combinations of Avenue and Gabrio varieties, fertilization with foliar fertilizer of any type and dose and at all levels of water supply, yield increases were highly significant relative to the unfertilized and non-irrigated Glosa variety.

But in relation to the non-irrigated variety at each of the gradations of factor B - foliar fertilizer, for each of the varieties tested, either Glosa, Avenue or Gabrio, there were no statistically assured differences.



DL 5% = 1.92 q/ha; DL 1% = 2.56 q/ha; DL 0.1% = 3.32 q/ha

Figure 3. Influence of irrigation water supply (C-factor) on wheat yield - Caracal 2023-2024

The largest increases, were recorded for each of the varieties at most of the factor B gradations at the 75% supply level but without significance. However, the variety Glosa responded best, with yields over 6 q/ha, when fertilized with Foliq 36N 3L/ha and Foliq Cereal 1L/ha and irrigated at 75% IUA, but again without statistical assurance (Table 5).

Table 5. Influence of the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) on wheat yield - Caracal 2023-2024

FACTOR A	FACTOR B	FACTOR C	Yield (q/ha)	Dif. mt 1	Semnif.	Dif. mt 2	Semnif.
GLOSA	UNFERTILIZED	NON-IRRIGATED (mt1)	55.51	0.00			
GLOSA	UNFERTILIZED	NON-IRRIGATED (mt2)	55.51	0.00		0.00	
		IR 50% IUA	58.99	3.48		3.48	
		IR 75% IUA	58.20	2.69		2.69	
	FOLIQ 36 N 3 L/HA	NON-IRRIGATED (mt2)	53.26	-2.25		0.00	
		IR 50% IUA	58.64	3.13		-2.46	
		IR 75% IUA	60.74	5.23		6.02	
	FOLIQ 36 N 5 L/HA	NON-IRRIGATED (mt2)	56.46	0.95		0.00	
		IR 50% IUA	59.77	4.26		3.31	
		IR 75% IUA	59.84	4.33		3.38	
	FOLIQ CEREALS 1 L/HA	NON-IRRIGATED (mt2)	55.66	0.15		0.00	
		IR 50% IUA	58.32	2.81		2.66	
		IR 75% IUA	61.82	6.31		6.16	
	FOLIQ CEREALS 2 L/HA	NON-IRRIGATED (mt2)	56.70	1.19		0.00	
		IR 50% IUA	57.29	1.78		0.59	
		IR 75% IUA	57.01	1.50		0.31	
ANENUE	UNFERTILIZED	NON-IRRIGATED (mt2)	77.70	22.19	***	0.00	
		IR 50% IUA	76.40	20.89	***	-1.30	
		IR 75% IUA	75.97	20.46	***	-1.73	

	FOLIQ 36 N 3 L/HA	NON-IRRIGATED (mt2)	77.73	22.22	***	0.00	
		IR 50% IUA	76.07	20.56	***	-1.66	
		IR 75% IUA	82.28	26.77	***	4.55	
	FOLIQ 36 N 5 L/HA	NON-IRRIGATED (mt2)	77.58	22.07	***	0.00	
		IR 50% IUA	79.18	23.67	***	1.60	
		IR 75% IUA	77.98	22.47	***	0.40	
	FOLIQ CEREALS 1 L/HA	NON-IRRIGATED (mt2)	74.49	18.98	***	0.00	
		IR 50% IUA	76.84	21.33	***	2.35	
		IR 75% IUA	79.00	23.49	***	4.51	
	FOLIQ CEREALS 2 L/HA	NON-IRRIGATED (mt2)	75.05	19.54	***	0.00	
		IR 50% IUA	77.92	22.41	***	2.87	
		IR 75% IUA	78.97	23.46	***	3.92	
GABRIO	UNFERTILIZED	NON-IRRIGATED (mt2)	83.16	27.65	***	0.00	
		IR 50% IUA	85.32	29.81	***	2.16	
		IR 75% IUA	83.64	28.13	***	0.48	
	FOLIQ 36 N 3 L/HA	NON-IRRIGATED (mt2)	80.12	24.61	***	0.00	
		IR 50% IUA	83.37	27.86	***	3.25	
		IR 75% IUA	83.54	28.03	***	3.42	
	FOLIQ 36 N 5 L/HA	NON-IRRIGATED (mt2)	84.89	29.38	***	0.00	
		IR 50% IUA	87.87	32.36	***	2.98	
		IR 75% IUA	80.66	25.15	***	-4.23	
	FOLIQ CEREALS 1 L/HA	NON-IRRIGATED (mt2)	81.55	26.04	***	0.00	
		IR 50% IUA	83.08	27.57	***	1.53	
		IR 75% IUA	85.34	29.83	***	3.79	
	FOLIQ CEREALS 2 L/HA	NON-IRRIGATED (mt2)	80.84	25.33	***	0.00	
		IR 50% IUA	83.34	27.83	***	2.50	
		IR 75% IUA	85.60	30.09	***	4.76	
	DL 5%		7.44 q/ha				
	DL 1%		9.89 q/ha				
	DL 0.1%		12.86 q/ha				

The distribution of production values grouped by varieties evaluated by the box-plot method shows a narrower range of values for Glosa and Avenue compared to Gabrio (Figure 4). This distribution showed a marked stability of the yields of Glosa but in obtaining low yields, an undesirable characteristic in agricultural practice.

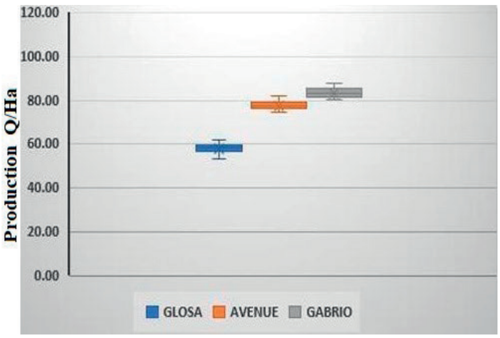


Figure 4. Box-plot synthesis of yield results by the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) grouped by variety - Caracal 2023-2024

The table below highlights the minimum, maximum, mean, 25% and 75% limits, maximum-minimum amplitude and inter-quartile range for the interaction variety x foliar fertilizer x irrigation water supply, grouped by variety (Table 6).

Table 6. Yield values for the box-plot calculation through the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigation water supply (factor C) grouped by variety - Caracal 2023-2024

	Glosa	**Avenue**	**Gabrio**
Minimum value	53.25724	74.49391	80.12054
Q1 (limit of 25% of values)	56.58216	76.23268	82.31332
Median (limit of 50% of values	58.20402	77.69886	83.36556
Q3 (limit of 75% of values)	59.37881	78.47392	85.10697
Maximum value	61.82167	82.28474	87.87221
Mean value	57.88	77.54	83.49
Maximum-minimum amplitude	8.564433	7.790831	7.751666
IQR (interquartil = Q3 – Q1)	2.796652	2.241237	2.793653
IQR x 1,5	4.194979	3.361855	4.190479
IQR x 3	8.389957	6.72371	8.380959

The distribution of the yield values grouped by fertilization levels, evaluated by the box-plot method, showed a somewhat narrower range of

values for Foliq Cereal fertilization at a dose of 1 l/ha, but also the fact that there is no outlier or extreme value (Figure 5).
From Table 7 it emerged that all box-plots have very close mean values and balanced towards the upper side.
The distribution of the yield values grouped by foliar fertilizer treatments, also evaluated by the box-plot method, showed a more pronounced instability for the Foliq Cereal 2 L/ha treatment.

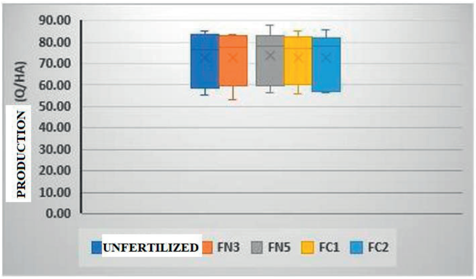
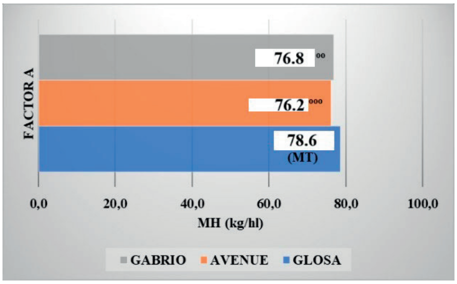


Figure 5. Box-plot synthesis of yield results by the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) grouped by type and dose of foliar fertilizer - Caracal 2023-2024

Table 7. Yield values for the box-plot calculation by the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) grouped by type and dose of foliar fertilizer - Caracal 2023-2024

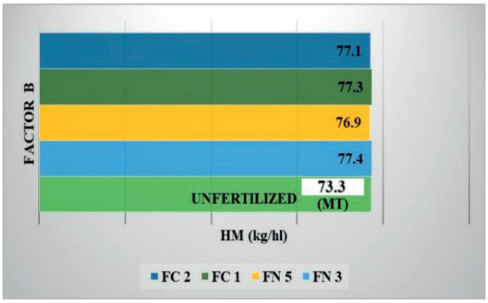
Minimum value	55.50913	53.25724	56.46476	55.66203	56.6995543
Q1 (limit of 25% of values)	58.99082	60.74036	59.83685	61.82167	57.2931781
Median (limit of 50% of values	76.4	77.72917	77.98234	76.84268	72.8602965
Q3 (limit of 75% of values)	83.16063	82.28474	80.66106	81.55009	80.8418158
Maximum value	85.32068	83.53503	87.87221	85.34416	85.5980432
Mean value	72.77	72.86	73.80	72.90	72.53
Maximum-minimum amplitude	29.81155	30.27779	31.40745	29.68213	28.8984889
IQR (interquartil = Q3 – Q1)	24.16981	21.54439	20.82421	19.72842	23.5486378
IQR x 1,5	36.25472	32.31658	31.23632	29.59263	35.3229566
IQR x 3	72.50944	64.63316	62.47264	59.18525	70.6459133

As in the case of yield, on average over the two years there were statistically assured differences in hectolitre mass between varieties, but in the opposite direction.
The foreign varieties showed low hectolitre mass, highly significant for Avenue and distinctly significant for Gabrio compared to Glosa (Figure 6).
Fertilization with foliar fertilizer, irrespective of the product and the dose applied, did not show significant differences in hectolitre mass compared to the non-fertilized variety (Figure 7).
The differences between the variants were extremely small and therefore not statistically assured.
Water supply influenced hectolitre mass. At 75% of the IUA, the hectolitre mass (HM) was distinctly significantly higher than the non-irrigated variant, with an increase of 1.8 kg/hl (Figure 8).
However, the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) greatly influenced the hectolitre mass.



DL 5% = 0.7 kg/hl; DL 1% = 1.1 kg/hl; DL 0.1% = 2.0 kg/hl

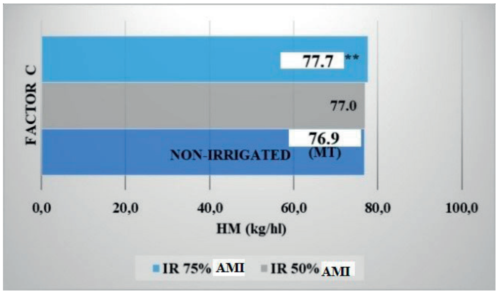
Figure 6. Influence of variety (factor A) on the hectolitre mass of wheat - Caracal 2023-2024



DL 5% = 0.7 kg/hl; DL 1% = 0.9 kg/hl; DL 0.1% = 1.3 kg/hl

Figure 7. Influence of foliar fertilizer (factor B) on the hectolitre mass of wheat – Caracal 2023+2024

Compared to the non-irrigated and non-fertilized variant of Glosa, most variants, but all of Avenue and Gabrio varieties, had much significantly, distinctly significantly or very significantly decreased hectolitre mass (Table 8). These decreases were in the range of 1.5-3.7 kg/hl, values that made the foreign varieties well below Glosa in this respect.



DL 5% = 0.6 kg/hl; DL 1% = 0.7 kg/hl; DL 0.1% = 0.9 kg/hl

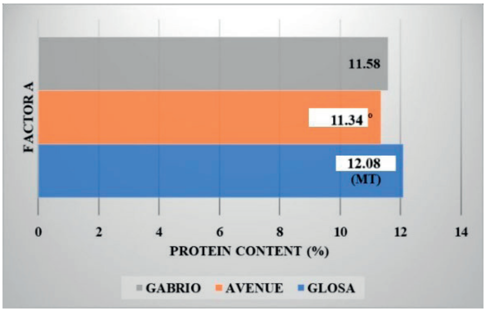
Figure 8. Influence of irrigation water supply (C-factor) on hectolitre mass of wheat - Caracal 2023-2024

Table 8. Influence of the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) on hectolitre mass in wheat - Caracal 2023-2024

FACTOR A	FACTOR B	FACTOR C	HM (kg/hl)	Dif. mt 1	Semnif.	Dif. mt 2	Semnif.
GLOSA	UNFERTILIZED	NON-IRRIGATED (mt1)	79.1	0.0			
GLOSA	UNFERTILIZED	NON-IRRIGATED (mt2)	79.1	0.0		0.0	
		IR 50% IUA	78.5	-0.6		-0.6	
		IR 75% IUA	78.2	-0.9		-0.9	
	FOLIQUE 36 N 3 L/HA	NON-IRRIGATED (mt2)	77.9	-1.2		0.0	
		IR 50% IUA	78.4	-0.7		0.5	
		IR 75% IUA	79.4	0.3		1.5	
	FOLIQUE 36 N 5 L/HA	NON-IRRIGATED (mt2)	78.5	-0.6		0.0	
		IR 50% IUA	78.0	-1.1		-0.5	
		IR 75% IUA	79.2	0.1		0.7	
	FOLIQUE CEREALS 1 L/HA	NON-IRRIGATED (mt2)	78.6	-0.5		0.0	
		IR 50% IUA	77.8	-1.3		-0.8	
		IR 75% IUA	80.0	0.9		1.4	
	FOLIQUE CEREALS 2 L/HA	NON-IRRIGATED (mt2)	78.3	-0.8		0.0	
		IR 50% IUA	77.8	-1.3		-0.5	
		IR 75% IUA	78.6	-0.5		0.3	
ANENUE	UNFERTILIZED	NON-IRRIGATED (mt2)	76.0	-3.1	oo	0.0	
		IR 50% IUA	76.2	-2.9	oo	0.2	
		IR 75% IUA	76.5	-2.6	o	0.5	
	FOLIQUE 36 N 3 L/HA	NON-IRRIGATED (mt2)	76.5	-2.6	o	0.0	
		IR 50% IUA	76.3	-2.8	oo	-0.2	
		IR 75% IUA	77.0	-2.1	o	0.5	
	FOLIQUE 36 N 5 L/HA	NON-IRRIGATED (mt2)	75.6	-3.5	oo	0.0	
		IR 50% IUA	75.4	-3.7	ooo	-0.2	
		IR 75% IUA	76.5	-2.6	o	0.9	
	FOLIQUE CEREALS 1 L/HA	NON-IRRIGATED (mt2)	75.5	-3.6	ooo	0.0	
		IR 50% IUA	76.3	-2.8	oo	0.8	
		IR 75% IUA	77.0	-2.1	o	1.5	
	FOLIQUE CEREALS 2 L/HA	NON-IRRIGATED (mt2)	76.0	-3.1	oo	0.0	
		IR 50% IUA	76.8	-2.3	o	0.8	
		IR 75% IUA	75.9	-3.2	oo	-0.1	
GABRIO	UNFERTILIZED	NON-IRRIGATED (mt2)	75.7	-3.4	oo	0.0	
		IR 50% IUA	77.6	-1.5		1.9	
		IR 75% IUA	77.7	-1.4		2.0	
	FOLIQUE 36 N 3 L/HA	NON-IRRIGATED (mt2)	76.3	-2.8	oo	0.0	
		IR 50% IUA	76.6	-2.5	o	0.3	
		IR 75% IUA	77.9	-1.2		1.6	

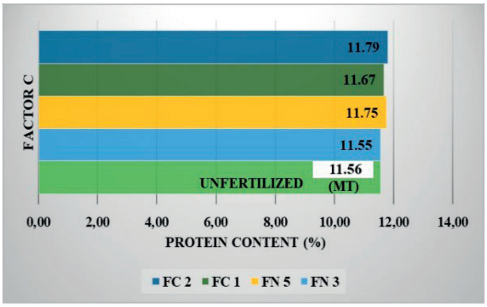
	FOLIQUE 36 N 5 L/HA	NON-IRRIGATED (mt2)	76.4	-2.8	oo	0.0	
		IR 50% IUA	76.4	-2.7	o	0.0	
		IR 75% IUA	76.5	-2.6	o	0.1	
	FOLIQUE CEREALS 1 L/HA	NON-IRRIGATED (mt2)	76.6	-2.5	o	0.0	
		IR 50% IUA	76.7	-2.4	o	0.1	
		IR 75% IUA	77.5	-1.6		0.9	
	FOLIQUE CEREALS 2 L/HA	NON-IRRIGATED (mt2)	76.0	-3.1	oo	0.0	
		IR 50% IUA	76.9	-2.2	o	0.9	
		IR 75% IUA	77.7	-1.4		1.7	
	DL 5%		2.1 kg/hl				
	DL 1%		2.8 kg/hl				
	DL 0.1%		3.6 kg/hl				

On average over the 2 years, protein content was influenced by variety. The protein content value of Avenue was significantly decreased compared to Glosa but not compared to Gabrio (Figure 9). Foliar fertilization and water supply did not influence the protein content (Figures 10 and 11).



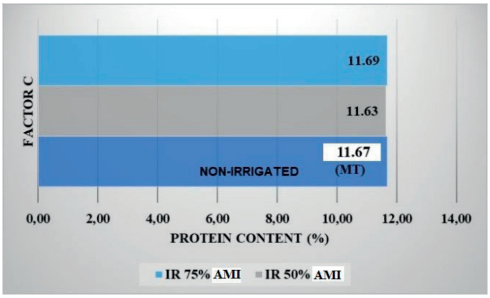
DL 5% = 0.53%; DL 1% = 0.88%; DL 0.1% = 0.65%

Figure 9. Influence of variety (factor A) on protein content in wheat - Caracal 2023-2024



DL 5% = 0.41%; DL 1% = 0.56%; DL 0.1% = 0.75%

Figure 10. Influence of foliar fertilizer (factor B) on protein content in wheat - Caracal 2023-2024



DL 5% = 0.28%; DL 1% = 0.38%; DL 0.1% = 0.49%

Figure 11. Influence of irrigation water supply (C-factor) on protein content in wheat - Caracal 2023-2024

The protein content values ranged from 10.52% for Avenue fertilized with Foliq 36 N 3 L/ha and irrigated at 50% of the IUA to 12.36% for Glosa fertilized with Foliq Cereal 2 L/ha and irrigated at 50% of the IUA. The foreign varieties had only one protein content value above 12% (12.16%) in Gabrio fertilized with Foliq Cereals 1 l/ha and irrigated at 50% of the IUA (Table 9).

The interaction of variety (factor A) x foliar fertilizer (factor B) x irrigation water supply (factor C) influenced protein content. Compared to the non-irrigated and non-fertilized variant of Glosa, seven variants of Avenue and Gabrio had significantly and distinctly significantly reduced hectolitre mass (Table 9). Based on these decreases, we do not recommend growing Avenue fertilized with Foliq36 N 3 kg/ha at 50% water level of IUA, a variant that has significantly reduced protein content also compared to itself unfertilized and non-irrigated.

Table 9. Influence of the interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) on the protein content of wheat - Caracal 2023-2024

FACTOR A	FACTOR B	FACTOR C	Protein (%)	Dif. mt 1	Semnif.	Dif. mt 2	Semnif.
GLOSA	UNFERTILIZED	NON-IRRIGATED (mt1)	12.31	0.00			
GLOSA	UNFERTILIZED	NON-IRRIGATED (mt2)	12.31	0.00		0.00	
		IR 50% IUA	11.33	-0.98		-0.98	
		IR 75% IUA	11.96	-0.35		-0.35	
	FOLIQUE 36 N 3 L/HA	NON-IRRIGATED (mt2)	12.24	-0.07		0.00	
		IR 50% IUA	11.89	-0.42		-0.35	
		IR 75% IUA	11.94	-0.37		-0.30	
	FOLIQUE 36 N 5 L/HA	NON-IRRIGATED (mt2)	12.30	-0.01		0.00	
		IR 50% IUA	12.25	-0.06		-0.05	
		IR 75% IUA	12.26	-0.05		-0.04	
	FOLIQUE CEREALS 1 L/HA	NON-IRRIGATED (mt2)	12.31	0.00		0.00	
		IR 50% IUA	12.17	-0.14		-0.14	
		IR 75% IUA	11.91	-0.40		-0.40	
	FOLIQUE CEREALS 2 L/HA	NON-IRRIGATED (mt2)	12.07	-0.24		0.00	
		IR 50% IUA	12.36	0.05		0.29	
		IR 75% IUA	11.84	-0.47		-0.23	
ANENUE	UNFERTILIZED	NON-IRRIGATED (mt2)	11.39	-0.92		0.00	
		IR 50% IUA	11.08	-1.23	o	-0.31	
		IR 75% IUA	11.40	-0.91		0.01	
	FOLIQUE 36 N 3 L/HA	NON-IRRIGATED (mt2)	11.72	-0.59		0.00	
		IR 50% IUA	10.52	-1.79	oo	-1.20	o
		IR 75% IUA	11.67	-0.64		-0.05	
	FOLIQUE 36 N 5 L/HA	NON-IRRIGATED (mt2)	10.89	-1.42	o	0.00	
		IR 50% IUA	11.77	-0.54		0.88	
		IR 75% IUA	11.84	-0.47		0.95	
	FOLIQUE CEREALS 1 L/HA	NON-IRRIGATED (mt2)	11.23	-1.08		0.00	
		IR 50% IUA	11.00	-1.31	o	-0.23	
		IR 75% IUA	10.97	-1.34	o	-0.26	
	FOLIQUE CEREALS 2 L/HA	NON-IRRIGATED (mt2)	11.39	-0.92		0.00	
		IR 50% IUA	11.97	-0.34		0.58	
		IR 75% IUA	11.27	-1.04		-0.12	
GABRIO	UNFERTILIZED	NON-IRRIGATED (mt2)	11.48	-0.83		0.00	
		IR 50% IUA	11.51	-0.80		0.03	
		IR 75% IUA	11.60	-0.71		0.12	
	FOLIQUE 36 N 3 L/HA	NON-IRRIGATED (mt2)	10.87	-1.44	o	0.00	
		IR 50% IUA	11.17	-1.14	o	0.30	
		IR 75% IUA	11.90	-0.41		1.03	
	FOLIQUE 36 N 5 L/HA	NON-IRRIGATED (mt2)	11.46	-0.85		0.00	
		IR 50% IUA	11.60	-0.71		0.14	
		IR 75% IUA	11.38	-0.93		-0.08	
	FOLIQUE CEREALS 1 L/HA	NON-IRRIGATED (mt2)	11.58	-0.73		0.00	
		IR 50% IUA	12.16	-0.15		0.58	
		IR 75% IUA	11.68	-0.63		0.10	
	FOLIQUE CEREALS 2 L/HA	NON-IRRIGATED (mt2)	11.87	-0.44		0.00	
		IR 50% IUA	11.68	-0.63		-0.19	
		IR 75% IUA	11.69	-0.62		-0.18	
	DL 5%		**1.10%**				
	DL 1%		**1.46%**				
	DL 0.1%		**1.90%**				

CONCLUSIONS

The world market and, lately, the Romanian market, have been invaded by numerous products acting as fertilizers for wheat crops. The aim of the study carried out on Caracal chernozem was to determine the influence of foliar fertilizer application on yield and quality, depending on the variety and the optimal time of application in terms of soil water supply.

Analysis of the influence of single factors showed that yield and hectolitre mass were influenced by variety and water supply. Protein content was only influenced by variety.

The yields of Avenue and Gabrio were significantly higher than the control - Glosa, with substantial differences (+19.66 q/ha and +25.61 q/ha respectively). In addition, the rainfall in May, just at the grain filling phenotype, coupled with lower than normal temperatures, greatly helped the foreign varieties, creating a microclimate conducive to maximizing their productive capacity.

The distribution of production values grouped by variety evaluated by the box-plot method showed a marked stability of yields for the Glosa variety, but in obtaining low yields, an undesirable characteristic in agricultural practice.

As in the case of yields, statistically assured differences in hectolitre mass were recorded between varieties. The foreign varieties showed low hectolitre mass, highly significant for Avenue and distinctly significant for Gabrio compared to Glosa.

Fertilization with foliar fertilizer, irrespective of the product and the dose applied, did not reveal significant differences in hectolitre mass in relation to the non-fertilized variety. The differences between the variants were extremely small and therefore not statistically assured.

Water supply influenced hectolitre mass. The interaction of variety (factor A) x foliar fertilizer (factor B) x irrigated water supply (factor C) influenced the protein content.

Among the tested variants we recommend the variety Gabrio fertilized with Foliq 36 N 5 kg and irrigated at 50% of the A.I.U.

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