RESEARCH ON THE INCREASE OF TRITICALE PRODUCTION THROUGH THE MODIFICATION OF THE SOWING RATE AND SUPPLEMENTARY FERTILIZATION, IN THE CLIMATE CONDITIONS OF 2023-2024 IN NORTH-WESTERN ROMANIA

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Abstract. *Triticale are known around the world for their properties, borrowed from the genera Triticum aestivum and Secale cereale. They have a high production capacity and a high content of protein and lysine, show a very good resistance to abiotic and biotic stress, and have a high capacity to capitalize on low fertility and acid lands, lands where wheat cannot be cultivated. Along with the advancement of technology and science, the use of triticale grains and plants has seen new fields of use. In addition to feeding animals in different forms, triticale production is also used in the bioethanol, cellulose industry, in the bakery industry and in the manufacture of biscuits, beer, in the food packaging industry, in human medicine and in diets, aquaculture, etc. Due to the expansion of the use of this culture, the need to obtain higher productions is absolutely necessary. In the current study, which took place at the Livada Agricultural Research and Development Station, in Satu-Mare county, northwest Romania, in the period 2023-2024. It was based on the testing of 4 varieties of triticale that were sown in different sowing rates and that received different fertilization schemes, the control version was based on chemical fertilization at the soil level, with complex fertilizer in the fall, and with Nitrolime in the spring vegetation. The experiment was placed under the method of subdivided plots, having three experimental factors; the variety, with 4 graduations, the fertilization, with 3 graduations, the seed size, with 3 graduations. In the pedoclimatic conditions of the reference area, it was found that the Utrifun variety was the most productive, it reacted favorably to the additional fertilization with foliar fertilizer and signed at a plot of 550 seeds/m^2 , obtaining productions of over 11.000 kg/ha, in in the case of additional fertilization and with biostimulator, the production started to decrease, however, Utrifun fertilized only in the soil managed to produce over 10.000 kg/ha. This was followed by the Zvelt variety, the latter being Tulnic. These results were obtained under conditions specific to the 2023-2024 period, and in the following years it will be established whether additional fertilization with foliar fertilizers ensures increases in production and whether the additional application of a biostimulator leads to increased production.*

Key words: *triticale, technology, fertilization, biostimulator, variety*

INTRODUCTION

Triticale has come to have an increasing importance at the global level and to be cultivated on larger and larger areas together with other cereals, reaching in the year 2022 a global area of 3.6 million ha, with an average yield of over 3.9 t/ha, higher than that of wheat, with over 220 kg/ha. This fact is due to the high production they obtain, a character borrowed from wheat (*Triticum aestivum*), they are also very resistant to biotic and abiotic stress factors, and they make good use of poorly fertile and acidic lands, characters borrowed from rye (*Secale cereal*). These properties make triticale an excellent substitute for wheat and rye culture (Mergorum et. al., 2009). The chemical composition of the grains is between wheat and rye, with a high protein content, close to that of wheat, between 11.4 and 14% (Heger and Eggum, 1991), and a high lysine content, between 0.33 and 0.71%, character borrowed from rye (Fraś et al., 2021; Fraś et al., 2016).

Due to the similar chemical composition of the two species, triticale is used all over the world in different forms. Since the last century, triticale grains have been used in animal feed in different forms, grains, especially for pigs and birds, the secondary production being represented by straw is used in animal feed or as bedding, the grains are part of concentrated feed rations or it is also used as silage and in grazing mixed with other species from the *Poaceae* familysuch as *Lolium multiflorum* (Glamoclija et al., 2018, Baron et al. 2015). Another use is that of the bioethanol industry (Mupondwa et al., 2018), but after several studies it was found that the starch content of triticale grains is influenced especially by the area where it is cultivated and the level of nitrogen fertilization

(Obuchowski et al., 2010). A limiting factor in the use of grains in the bakery industry is the high level of lysine. Quite acceptable triticale flour products were prepared (K. Lorenz and Dr. Yeshajahu Pomeranz, 2009). Triticale grains can also be used in the beer industry, but in a rather low percentage, somewhere around 25%, which led to an increase in the viscosity of the wort and a decrease in the filterability of the beer (Glatthar et. al., 2003). Due to the presence of phenolic acids in flour and bran, it was found that they have an antibacterial and antioxidant role, which gives triticale the ability to be used in human medicine (Jańczak-Pieniązek et al., 2023). They can also be used in the cellulose industry, food packaging and even in fish feed (Salvucci et al., 2019; Bates et al., 2020; Tarres et al., 2017; Markovic et al., 2013).

Due to these varied areas of use, triticale has begun to receive increased importance in the world, increasing production being one of the main objectives of breeders and farmers. Worldwide, many studies are being done to determine the optimal dose of fertilizer and crop rotation, so as to obtain the highest possible yields (Đekić et. al., 2014; Gerdzhıkova 2014).

In addition to the previous studies, through this study we tried to determine the most productive sown variety, at an optimal rate of sowing and with an effective level of fertilization in order to obtain the highest possible productions under the conditions of northwestern Romania.

MATERIALS AND METHODS

The results presented in this paper were obtained during the agricultural year 2023-2024. This research proposes to contribute to the improvement of the triticale cultivation technology in the northwestern area of Romania, through the use of foliar fertilizers and biostimulators.

The plant preceding the cultivation of triticale was the fodder pea. After harvesting it in July, the land was deforested, then in September 2023 plowing was carried out at a depth of 23-25 cm. The land was prepared with a disk harrow, after which it was fertilized with NPK 18-46-0 chemical complex fertilizer in a dose of 150 kg/ha. The fertilizer was incorporated with the combiner when preparing the seed bed.

In the spring, when the straw lengthened, the four varieties of triticale were additionally fertilized with Ammonium nitrate 27% N in a dose of 300 kg/ha. After this, in April weed control was carried out with the herbicide Sekator Progress OD in a dose of 0.15 l/ha. It has as active substances amidosulfuron 100 g/l, iodosulfuron-methyl-Na 25 g/l and mefenpyr diethyl 250 g/l and fights a wide spectrum of dicotyledonous weeds (18). Combating foliar and ear diseases was carried out with the Nativo Pro product, which is a systemic fungicide that has as active substances prothioconazole 175 g/l + trifloxystrobin 150 g/l (19).On April 23, 2024, together with the fight against diseases, the B2 and B3 variants were additionally fertilized with foliar fertilizer and biostimulator

The experiment was located at the Livada Agricultural Research and Development Station, Satu Mare county, on a typical preluvosol type soil with a low humus content in the arable layer and an acidic soil reaction. This type of soil consists of the following soil horizons.

Ap horizon- the processed A—it has a depth of 0–18 cm and is the horizon from the surface that is being processed. The humus content is 2.82% and has a pH of 5.19 and 20.9%g/g clay.

Ao horizon—18–40 cm deep; it has a light color, acid pH, and low humus content.

AB horizon—40–55 cm deep, it is a transitional horizon, with weak acid reaction but with a high clay content.

Bt1w horizon—55–70 cm deep, it is formed by the accumulation of elevated clay. The yellowish-reddish color is given by the accumulation of Fe oxides, a process due to the stagnation of water in the soil profile above a waterproof.

Bt2w horizon—70–110 cm deep; it has a low pH and high clay content (Table 1).

Table 1. Soil characteristics from the experimental field in Livada

Specification	UM	Ap	Ao		AB	Bt_1w	Bt_2w
	cm	0-18	18-40		40-55	55-70	70-110
	cm	0.15	20-30	30-40	40-55	55-70	80-95
Hummus (Cx1.72)	%	2.82	1.44	0.90	0.90	0.84	3.24
C:N	-	8.21	9.15	10.14	10.34	10.57	-
pH in water	-	5.19	6.24	6.65	6.53	5.62	5.28
Clay (<0.002mm)	%w/w	20.9	21.1	23.1	27.0	32.4	33.1

Apparent density	g/cm ^{3}	1.35	1.54	1.49	1.48	-	1.48
Hydraulic Conductivity	mm/h	31.27	5.87	3.11	0.35	-	1.04

UM—unit of measure; Ap, Ao, AB, Bt1w, Bt2w—soil horizon; C:N—carbon-nitrogen ratio, N total - nitrogen total.

The climatic conditions during the vegetation period are presented in table 2. In the period October 2023-June 2024, the average temperature was 10.2ºC, 3.2ºC higher than the multi-year average temperature. The biggest difference between the average temperature and the multi-year temperature was recorded in February when its average was 7.5ºC, followed by March with a difference of 4.6ºC. Even though the temperatures were extremely high, the level of precipitation registered an increase of over 80 mm/m^2. The highest levels of precipitation were recorded in June (147.2 mm/m^2), November (128.7 mm/m^2) and December (126.1 mm/m^2).

Table 2. Monthly and mean temperature and monthly and the amount of rainfall during the two cropping seasons (2023/2024)

Year	Climatic factor	Month									Mean temp. (°C)	The amount (mm/m^2)
		October	Nov.	Dec.	January	Feb.	Apple.	April	May	June		
2023/ 2024	Temp. (°C)	13.3	5.9	3.0	1.4	7.5	9.3	13.1	17.4	21.3	10.2	
	Multi-year average	9.8	4.8	0.1	-2.0	0.1	4.7	10.5	15.8	19.0	7.0	
	Difference ±	3.5	1.1	2.9	3.4	7.4	4.6	2.6	1.6	2.3	+3.2	
	Rainfall (mm/m^2)	65.3	128.7	126.1	75.9	41.5	40.0	41.6	30.2	147.2		502.5
	Multi-year sum	54.4	57.4	62.8	49.3	44.2	45.7	50.9	75.5	90.8		419.2
	Difference ±	10.9	71.3	63.3	26.6	-2.7	-5.7	-9.3	-45.3	56.4		83.3

The experiment was trifactorial, in which four varieties of triticale created at INCDA Fundulea, Romania, were studied, representing the A factor, with four grades:

A1- Negoiu. This is a variety approved in 2012, which has a height of 110-120 cm and a thick and elastic straw. The spikes are large, pointed, with grains that have a white-matte color. If the conditions are optimal, the mass of 1000 grains is between 48 and 54 g, and the hectoliter mass is 72-74 kg/hl (20).

A2- Utrifun. It was approved in 2018, it has a lower waist than Negoiu (85-95 cm), the mass of 1000 grains reaches between 45-50 g and the hectoliter mass of 72-76 kg/hl. The spikes are large, with white grains (21).

A3- Zvelt. Created in 2020, a tall variety between 110 and 120 cm, with medium-sized spikes and a reddish yellow color, pointed. The mass of 1000 grains can reach up to 54 g and the hectoliter mass up to 77 kg/hl (22).

A4- Tulnic. This variety was registered in 2017, it is a variety with a size similar to Negoiu and Zvelt (110-118 cm), with white-matte ears. The mass of 1000 berries can reach up to 58 g and the hectoliter mass up to 75 kg/hl (23).

Factor B was represented by the fertilization scheme, with three grades:B1:- basic fertilization, autumn-150 kg/ha NPK 18:46:0, additional fertilization, spring-300 kg/ha Ammonium nitrate 27 % N; B2- basic fertilization, autumn-150 kg/ha NPK 18:46:0, additional fertilization, spring-300 kg/ha Calcium ammonium nitrate 27 % N + foliar fertilization NPK 10:10:10 in a dose of 3 l/ha; B3 - basic fertilization, autumn-150 kg/ha NPK 18:46:0, additional fertilization, spring-300 kg/ha Calcium ammonium nitrate 27 % N + foliar fertilization NPK 10:10:10 in a dose of 3 l/ha + Cropmax biostimulator in a dose of 1 l/ha

Factor C was represented by the seeding rate of the 4 varieties of triticale, with three grades in three repetitions, they have: C1- 450 seeds/m ^{2}, C2- 550 seeds/m ^{2}, C3- 650 seeds/m ^{2}(Figure 1).

A1	**B1**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
	B2	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
	B3	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
A2	**B1**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
	B2	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
	B3	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**
A3	**B1**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**	**C1**	**C2**	**C3**

	B2	C1	C2	C3	C1	C2	C3	C1	C2	C3
	B3	C1	C2	C3	C1	C2	C3	C1	C2	C3
A4	B1	C1	C2	C3	C1	C2	C3	C1	C2	C3
	B2	C1	C2	C3	C1	C2	C3	C1	C2	C3
	B3	C1	C2	C3	C1	C2	C3	C1	C2	C3

Figure 1 . Layout of the experience

A1 – Negoiu; A2 – Utrifun; A3 – Zvelt; A4 – Tulnic;
B1 - chemical fertilization;
B2 – chemical fertilization + foliar fertilization;
B3 – chemical fertilization + foliar fertilization + biostimulator;
C1- 450 seeds/m ^{2}; C2- 550 seeds/m ^{2}; C3- 650 seeds/m ^{2}

The experimental variants were sown in October 2023 in the plot of 12 m ^{2} (10 m ^{2} harvestable) with the Wintersteiger experimental seeder (Figure 2).

Figure 2. Sowing experience with the Wintersteiger seeder

RESULTS AND DISCUSSIONS

According to the variant analysis, the greatest influence on triticale production in 2024 was the experimental factors variety and fertilization, having a very significantly positive influence on production. The interaction between these two factors had a distinctly positive influence on production. The experimental factor seeding rate had no influence on triticale production (Table 3).

Table 3. Analysis of the variant

Variant	Symbol	Sum of squares	Degrees of freedom	Mean square	Sample F	Theoretical F	Significance
Variety	A	222425700.00	3	74141900.00	88.275	4.76; 9.78; 23.70	XXX
Fertilization	B	30006700.00	2	15003350.00	52.053	3.63; 6.23; 10.97	XXX
Density	C	614094.40	2	307047.20	1.228	3.18	-
Variety x Fertilization	AB	11162780.00	6	1860463.00	6.455	2.74; 4.20; 6.80	XX
Variety x Density	AC	1096402.00	6	182733.70	0.731	2.29	-
Fertilization x Density	BC	239947.40	4	59986.85	0.240	2.56	-
Variety x Density x Fertilization	ABC	3383233.00	12	281936.10	1.128	1.95	-
Variety error	A error	5039403.00	6	839900.40	-	-	-
Density error	B error	4611739.00	16	288233.70	-	-	-
Fertilization error	C error	12001600.00	48	250033.30	-	-	-
Total			107	-	-	-	-

The production capacity in 2024 for triticale was influenced by the variety. Utrifun registered very significantly positive differences compared to the Negoiu control, with a production increase of over 3900 kg/ha. Utrifun was followed by Zvelt, with a production increase of over 2100 kg/ha. The Tulnic variety recorded a distinctly significant positive difference compared to the control (Negoiu variety) (+1358 kg/ha) (Table 4).

Table 4. Influence of factor A (variety) on production

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
Negoiu	A1 (Ck)	6958	100.0	0.00	Ck.
Utrifun	A2	10930	157.1	3972	***
Zvelt	A2	9073	130.4	2115	***
Tulnic	A4	8316	119.5	1358	**
LSD (p 5%) 611 kg/ha LSD (p 1%) 925 kg/ha LSD (p 0.1%) 1487 kg/ha					

In 2024, additional fertilization with foliar fertilizer and biostimulator ensured production increases of over 900 kg/ha. The experimental variants additionally fertilized with foliar fertilizer recorded very significantly positive production differences, ensuring an increase of 977 kg/ha. The variants fertilized with foliar fertilizer and biostimulator obtained a production increase of 1219 kg/ha, registering very significant positive differences compared to the control fertilized only chemically in autumn and spring (Table 5).

Table 5. Influence of factor B (fertilization) on production

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
Chemical fertilization	B1 (Ck)	8087	100.0	0.00	Ck.
Chemical fertilization + foliar fertilization	B2	9064	112.1	977	***
Chemical fertilization + foliar fertilization + biostimulator	B3	9306	115.1	1219	***
LSD (p 5%)268 kg/ha LSD (p 1%) 370 kg/ha LSD (p 0.1%) 509 kg/ha					

Changing the seeding rate did not bring significant increases in production. However, the density of 650 seeds/m ^{2} brought a production increase of 163 kg/ha (Table 6).

Table 6. Influence of factor C (density of sowing) on production

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
550 seeds/m ^{2}	C2 (Ck)	8763	100.0	0.00	Ck.
450 seeds/m ^{2}	C1	8769	100.1	6	-
650 seeds/m ^{2}	C3	8926	101.9	163	-
LSD (p 5%) 236 kg/ha LSD (p 1%) 316 kg/ha LSD (p 0.1%) 413 kg/ha					

The interaction between the experimental factor variety and the experimental factor fertilization recorded significant production differences compared to the control.

The highest production increases were recorded by the Utrifun variety, chemically and foliarly fertilized (A2 x B2), +4745 kg/ha, followed by Utrifun, only chemically fertilized, +4315 kg/ha, the interaction between them registering very significant differences positive.

The smallest production difference was obtained in the case of the Tulnic variety, chemically fertilized with foliar fertilizer and biostimulator. It recorded significantly positive differences (+903 kg/ha) compared to the control (Table 7).

Table 7. The interaction A x B factors (variety x fertilization)

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
Negoiu x Chemical fertilization	A1 B1	6157	100.0	0.00	Ck.
Utrifun x Chemical fertilization	A2 B1	10472	170.0	4315	***
Zvelt x Chemical fertilization	A3 B1	8468	137.5	2312	***
Tulnic x Chemical fertilization	A4 B1	7251	117.8	1095	*
Negoiu x Chemical fertilization + foliar fertilization	A1 B2	6697	100.0	0.00	Ck.
Utrifun x Chemical fertilization + foliar fertilization	A2 B2	11442	170.8	4745	***
Zvelt x Chemical fertilization + foliar fertilization	A3 B2	9344	139.5	2647	***
Tulnic x Chemical fertilization + foliar fertilization	A4 B2	8774	131.0	2077	***
Negoiu x Chemical fertilization + foliar fertilization + biostimulator	A1 B3	8020	100.0	0.00	Ck.
Utrifun x Chemical fertilization + foliar fertilization + biostimulator	A2 B3	10877	135.6	2857	***
Zvelt x Chemical fertilization + foliar fertilization + biostimulator	A3 B3	9405	117.3	1385	**
Tulnic x Chemical fertilization + foliar fertilization + biostimulator	A4 B3	8923	111.3	903	*
LSD (p 5%) 750 kg/ha LSD (p 1%) 1098 kg/ha LSD (p 0.1%) 1675 kg/ha					

The interaction between the experimental factor variety and the experimental factor seeding rate recorded significantly positive and very significantly positive production differences compared to the control variant.

The biggest production difference was obtained by Utrifun, sown at 550 seeds/m^2, this statistically ensuring a production increase of 4195 kg/ha. Utrifun sown at 650 seeds/m^2 (+4035) and Utrifun sown at 450 seeds/m^2 (+3686 kg/ha) have very significantly positive production differences compared to the control.

Tulnic, in all sowing plots, obtained smaller increases in production, +1345 kg/ha at 450 seeds/m^2, +1354 kg/ha at 550 seeds/m^2 and +1376 kg/ha at 650 seeds/m^2, the differences being distinctly significantly positive compared to the control variant (Table 8).

Table 8. The interaction A x C factors (variety x density sowing)

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
Negoiux 450 seeds/m ^{2}	A1 C1	7043	100.0	0.00	Ck.
Utrifun x 450 seeds/m ^{2}	A2 C1	10729	152.3	3686	***
Zveltx 450 seeds/m ^{2}	A3 C1	8916	126.6	1873	***
Tulnic x 450 seeds/m ^{2}	A4 C1	8388	119.1	1345	**
Negoiu x 550 seeds/m ^{2}	A1 C2	6833	100.0	0.00	Ck.
Utrifun x 550 seeds/m ^{2}	A2 C2	11028	161.4	4195	***
Zveltx 550 seeds/m ^{2}	A3 C2	9005	131.8	2172	***
Tulnic x 550 seeds/m ^{2}	A4 C2	8186	119.8	1354	**
Negoiu x 650 seeds/m ^{2}	A1 C3	6998	100.0	0.00	Ck.
Utrifun x 650 seeds/m ^{2}	A2 C3	11033	157.7	4035	***
Zveltx 650 seeds/m ^{2}	A3 C3	9297	132.9	2299	***
Tulnic x 650 seeds/m ^{2}	A4 C3	8375	119.7	1376	**
LSD (p 5%) 720 kg/ha LSD (p 1%) 1048 kg/ha LSD (p 0.1%) 1589 kg/ha					

According to expectations, the increase in production is influenced by the sowing rate and the additional fertilization with foliar fertilizer and biostimulator. All additionally fertilized variants recorded production increases of over 800 kg/ha compared to the control variant.

The biggest increase in production was recorded for the variants sown at 650 seeds/m^2 additionally fertilized with foliar fertilizer and biostimulator (+1351 kg/ha), having very significantly positive differences in production.

The lowest statistically guaranteed increase in production was obtained in the variants sown with 450 seeds/m^2 additionally fertilized only with foliar fertilizer (+886 kg/ha), the differences being nevertheless very significantly positive compared to the control (Table 9).

Table 9. The interaction B x C factors (fertilization x density sowing)

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
Chemical fertilization x 450 seeds/m^2	B1 C1	8106	100.0	0.00	Ck.
Chemical fertilization + foliar fertilizationx 450 seeds/m^2	B2 C1	8991	110.9	886	***
Chemical fertilization + foliar fertilization + biostimulatorx 450 seeds/m^2	B3 C1	9210	113.6	1104	***
Chemical fertilization x 550 seeds/m^2	B1 C2	8050	100.0	0.00	Ck.
Chemical fertilization + foliar fertilization x 550 seeds/m^2	B2 C2	8985	111.6	935	***
Chemical fertilization + foliar fertilization + biostimulatorx 550 seeds/m^2	B3 C2	9254	115.0	1204	***
Chemical fertilizationx 650 seeds/m^2	B1 C3	8105	100.0	0.00	Ck.
Chemical fertilization + foliar fertilizationx 650 seeds/m^2	B2 C3	9216	113.7	1111	***
Chemical fertilization + foliar fertilization + biostimulatorx 650 seeds/m^2	B3 C3	9456	116.7	1351	***
LSD (p 5%) 429 kg/ha LSD (p 1%) 580 kg/ha LSD (p 0.1%) 773 kg/ha					

Following the interaction between the three experimental factors, most variants recorded significant production differences.

The highest production increases were recorded by the Utrifun variety, sown in different thicknesses and additionally fertilized. The highest production was 11.417 kg/ha, with an increase of 4952 kg/ha compared to the control variant. This increase was obtained by Utrifun chemically fertilized, additionally fertilized and seeded at 550 seeds/m^2. Utrifun sown at 450 seeds/m^2, chemically fertilized and supplemented with foliar fertilizer registered an increase of 4772 kg/ha compared to the control variant. Utrifun sown at 550 seeds/m ^{2} and fertilized only chemically managed to obtain a production of over 10.600 kg/ha and a growth of 4556 kg/ha. So, as you can see, chemical and additional fertilization, regardless of the sowing rate, ensures the Utrifun variety increases in production of over 4000 kg/ha compared to the control. However, its production increments start to decrease with the intervention of the biostimulator, so it can be deduced that Utrifun does not react favorably to the additional fertilization with biostimulator, but it reacts favorably to the increase in sowing rate, so the production increment increases once the rate of sowing. At 450 seeds/m^2, chemically fertilized, with foliar fertilizer and biostimulator, it obtained an increase of only 2158 kg/ha. On the other hand, at the same level of fertilization, but sown at 550 and 650 seeds/m^2,he obtained increases of 3078 kg/ha, respectively 3336 kg/ha. All these growths having very significant positive differences compared to the control version.

The smallest productions were obtained by Tulnic in different fertilization options and at different rates. The insignificant production differences were obtained when Tulnic was sown at 450 seeds/m^2, it was chemically fertilized, foliar fertilized and fertilized with biostimulator (+444 kg/ha). Like Utrifun, the increases obtained by Tulnic increase with the increase in the sowing rate, thus under all three levels of fertilization, but sown at 550 seeds/m^2 obtained an increase of 736 kg/ha, and sown at 650 seeds/m^2 obtained an increase of 850 kg/ha. Additional fertilization with only foliar fertilizer provided the Tulnic variety with significantly positive increases in production. At 550 seeds/m^2 it recorded a production increase of over 2300 kg/ha, and at 450 seeds/m^2 an increase of over 2100 kg/ha was recorded.

It should be noted that all four varieties of triticale react in a negative way to the additional fertilization with biostimulator. The increases in production compared to the control variant begin to decrease in the variants

that were fertilized in addition to the foliar fertilizer and with biostimulator, and the increases in production increase with the increase in the sowing rate (Table 10).

Table 10. The interaction A x B x C factors (variety x fertilization x density sowing)

Variant	Symbol	Production (kg/ha)	%	The difference	Significance
Negoiu x chemical fertilization x 450 seeds/m^2	A1 B1 C1	6290	100.0	0.00	Ck.
Utrifun x chemical fertilization x 450 seeds/m^2	A2 B1 C1	10420	165.6	4129	***
Zvelt x chemical fertilization x 450 seeds/m^2	A3 B1 C1	8012	127.4	1722	**
Tulnic x chemical fertilization x 450 seeds/m^2	A4 B1 C1	7701	122.4	1410	**
Negoiu x chemical fertilization x 550 seeds/m^2	A1 B1 C2	6062	100.0	0.00	Ck.
Utrifun x chemical fertilization x 550 seeds/m^2	A2 B1 C2	10.618	175.2	4556	***
Zvelt x chemical fertilization x 550 seeds/m^2	A3 B1 C2	8434	139.1	2371	***
Tulnic x chemical fertilization x 550 seeds/m^2	A4 B1 C2	7085	116.9	1023	*
Negoiu x chemical fertilizationx 650 seeds/m^2	A1 B1 C3	6117	100.0	0.00	Ck.
Utrifun x chemical fertilizationx 650 seeds/m^2	A2 B1 C3	10377	169.6	4260	***
Zvelt x chemical fertilizationx 650 seeds/m^2	A3 B1 C3	8959	146.5	2842	***
Tulnic x chemical fertilizationx 650 seeds/m^2	A4 B1 C3	6968	113.9	850	-
Negoiu x chemical fertilization + foliar fertilizationx 450 seeds/m^2	A1 B2 C1	6576	100.0	0.00	Ck.
Utrifun x chemical fertilization + foliar fertilizationx 450 seeds/m^2	A2 B2 C1	11348	172.6	4772	***
Zvelt x chemical fertilization + foliar fertilizationx 450 seeds/m^2	A3 B2 C1	9285	141.2	2709	***
Tulnic x chemical fertilization + foliar fertilizationx 450 seeds/m^2	A4 B2 C1	8756	133.1	2179	***
Negoiu x chemical fertilization + foliar fertilization x 550 seeds/m^2	A1 B2 C2	6465	100.0	0.00	Ck.
Utrifun x chemical fertilization + foliar fertilization x 550 seeds/m^2	A2 B2 C2	11417	176.6	4952	***
Zvelt x chemical fertilization + foliar fertilization x 550 seeds/m^2	A3 B2 C2	9291	143.7	2825	***
Tulnic x chemical fertilization + foliar fertilization x 550 seeds/m^2	A4 B2 C2	8768	135.6	2303	***
Negoiu x chemical fertilization + foliar fertilization x 650 seeds/m^2	A1 B2 C3	7049	100.0	0.00	Ck.
Utrifun x chemical fertilization + foliar fertilization x 650 seeds/m^2	A2 B2 C3	11559	164.0	4510	***
Zvelt x chemical fertilization + foliar fertilization x 650 seeds/m^2	A3 B2 C3	9456	134.1	2407	***
Tulnic x chemical fertilization + foliar fertilization x 550 seeds/m^2	A4 B2 C3	8800	124.8	1750	**
Negoiu x chemical fertilization + foliar fertilization + biostimulatorx 450 seeds/m^2	A1 B3 C1	8262	100.0	0.00	Ck.
Utrifun x chemical fertilization + foliar fertilization + biostimulatorx 450 seeds/m^2	A2 B3 C1	10420	126.1	2158	***
Zvelt x chemical fertilization + foliar fertilization + biostimulatorx 450 seeds/m^2	A3 B3 C1	9450	114.4	1188	*

Tulnic x chemical fertilization + foliar fertilization + biostimulatorx 450 seeds/m^2	A4 B3 C1	8706	105.4	444	-
Negoiu x chemical fertilization + foliar fertilization + biostimulatorx 550 seeds/m^2	A1 B3 C2	7970	100.0	0.00	Ck.
Utrifun x chemical fertilization + foliar fertilization + biostimulatorx 550 seeds/m^2	A2 B3 C2	11048	138.6	3078	***
Zvelt x chemical fertilization + foliar fertilization + biostimulatorx 550 seeds/m^2	A3 B3 C2	9289	116.5	1319	*
Tulnic x chemical fertilization + foliar fertilization + biostimulatorx 550 seeds/m^2	A4 B3 C2	8706	109.2	736	-
Negoiu x chemical fertilization + foliar fertilization + biostimulatorx 650 seeds/m^2	A1 B3 C3	7828	100.0	0.00	Ck.
Utrifun x chemical fertilization + foliar fertilization + biostimulatorx 650 seeds/m^2	A2 B3 C3	11163	142.6	3336	***
Zvelt x chemical fertilization + foliar fertilization + biostimulatorx 650 seeds/m^2	A3 B3 C3	9476	121.1	1648	**
Tulnic x chemical fertilization + foliar fertilization + biostimulatorx 650 seeds/m^2	A4 B3 C3	9356	119.5	1529	**
	LSD (p 5%) 1003 Kg/ha LSD (p 1%) 1407 Kg/ha LSD (p 0.1%) 2004 Kg/ha				

CONCLUSIONS

The greatest influence on triticale production was caused by the experimental factors variety and fertilization, and by the interaction between them.

Additional fertilization with foliar fertilizer and biostimulator ensured production increases between 800 and 1200 kg/ha.

The experimental factor sowing rate did not register any significant difference in production.

In the interaction between the variety factor and fertilization, the Utrifun variety obtained the highest productions, this one additionally fertilized with foliar fertilizer obtained 11.442 kg/ha and a production increase compared to the control of +4750 kg/ha. Utrifun fertilized only with chemical fertilizer obtained a production of over 10.400 kg/ha and an increase compared to the control of +4315 kg/ha, these differences being very significantly positive. The lowest productions were recorded by the Tulnic variety, although they had significantly positive differences compared to the control.

Utrifun obtained the highest increase compared to the control in the variants sown at 550 seeds/m^2 (+4195 kg/ha), the variants sown at 650 seeds/m^2 obtained an increase of +4035 kg/ha, these differences being very significantly positive compared to the control variant.

In the interaction between the fertilization factor and the sowing rate factor, the most productive variants were those sown at 650 seeds/m^2 and which were chemically fertilized in autumn and spring, fertilized with foliar fertilizer and fertilized with biostimulator, ensuring production increases of over 1350 kg/ha.

The highest yields in the interaction between the three experimental factors were obtained by the Utrifun variety, fertilized with chemical fertilizer and foliar fertilizer and signed at 550 seeds/m^2, 11.417 kg/ha and 11.348 kg/ha fertilized with chemical fertilizer and with foliar fertilizer and signed at 650 seeds/m^2. Among the 4 varieties, Tulnic registered the smallest production differences compared to the control variant, this one fertilized with chemical fertilizer, foliar fertilizer and biosimulator, signed at 450 seeds/m^2,registered an increase of only 444 kg/ha, and Tulnic fertilized with chemical fertilizer and foliar fertilizer and signed at 550 seeds/m^2 obtained an increase of 736 kg/ha, and at 650 seeds/m^2 850 kg/ha.

It is worth noting that the production of the 4 varieties of triticale was negatively influenced by the additional fertilization with biostimulator, the production being lower in the variants fertilized with biostimulator

compared to the variants that were fertilized with foliar fertilizer, but the production of these increased once with increasing the sowing rate. From here we can conclude that in the year 2023-2024 additional fertilization and biostimulator does not bring greater production constraints compared to the variants fertilized only with foliar fertilizer, on the contrary, the productions decreased, but this aspect will be better analyzed in future researches in different environmental conditions.

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