

Recent Advances in Winter Triticale Breeding: New Highly-Performing Cultivars

Maria Voica^{1*}, Mariana Bălțatu¹, Alina Mihaela Delcea¹,
Cristina Mihaela Marinciu², Constanța Popescu³

¹Agricultural Research and Development Station Teleorman, Drăgănești Vlașca, Teleorman County, Romania

²National Agricultural Research and Development Institute, Fundulea, Călărași County, Romania

³Institute for Testing and Registration of Varieties, București, Romania

*Corresponding author. E-mail: voica_maria@yahoo.com

ABSTRACT

Triticale represents an important cereal crop for ensuring stable grain production under increasingly variable climatic conditions, and the development of well-adapted cultivars remains a key breeding objective. This paper presents the first triticale cultivars, Drăgănești and Egreta (released in 2025), developed at the Agricultural Research and Development Station (ARDS) Teleorman, following the initiation of a triticale breeding program based on germplasm transferred from NARDI-Fundulea (agronomic cycle 2019/2020).

The new triticale genotypes *Drăgănești (14225T1-02)* and *Egreta (16026T4-1)* were experimentally evaluated during period 2022-2025 under the National Triticale Trial (NTT), conducted annually by the National Agricultural Research Development Institute (NARDI)-Fundulea and Academy of Agricultural and Forrest Sciences (AAFS), across ten agricultural research development stations (ARDS), totaling 39 environments.

Comparative results against six registered cultivars released during 2018-2024 (*Zori*, *Zvelt*, *Utrifun*, *Zaraza*, *FDL Ascendent*, *FDL Caltrit*) and two check cultivars (*Haiduc* and *Utrifun*), revealed in the both novel cultivars high values of the most desirable agronomic traits such as: resistance to drought, heat, diseases and preharvest grain sprouting of grains in the ear, as well as earliness and other parameters associated with yield potential. These data were confirmed through official trials carried on at the State Institute for Testing and Registration of Varieties (SITRV) in six locations (2022-2024). Their level of adaptability to the different environmental conditions across the country, expressed by the maximum grain yield recorded (7-13%), higher to the check cultivars, recommends them to be successfully cultivated, in terms of yield and quality, in all favorable areas for triticale crop of Romania.

Diversification of triticale germplasm through specific methods remains a major current and future objective of the newly established triticale breeding program at ARDS Teleorman.

Keywords: triticale, breeding, new cultivars, yield, adaptability, drought and disease resistance.

INTRODUCTION

Diversifying the structure of species and genotypes grown in the same area represents the most reliable strategy to avoid the impact of the climatic changes that currently threatens the yield stability over the crops.

Triticale is a crop highly recommended for agronomic systems with low inputs as compared to wheat performance and even higher in unfavorable conditions for it (Mergoum et al., 2009, 2019). Triticale is generally cultivated for animal nutrition, the quality being similar to barley (De Zutter et al., 2023)

Triticale could be potentially harvested from milk to dough stages for silage production or as grains and as an intercropping partner resulting a more complete food and feed (Dordas and Lithourgidis, 2011; Maxin et al., 2017).

Triticale develops very early in season a vigorous root system and a good level of tolerance to various abiotic stresses and the poor and acid soils not suited for other cereals.

In Romania, the first interspecific hybrids Wheat/Rye were described in 1927 (Săulescu, 1927), and the first octoploid triticale was obtained in 1939 (Priadcencu, 1952), while a systematic triticale breeding program was

initiated in 1971 at the former Research Institute for Cereals and Industrial Crops (RICIC), now, National Agricultural Research Development Institute (NARDI) Fundulea.

Since then, the continuous genetic diversification of the Romanian triticale germplasm has been targeted by crossing Romanian and foreign triticale parents, use of Romanian wheat germplasm, that allow a real progress with regard to kernel filling, the improve of test weight and as a consequence, the yield potential. Transfer of semidominant genes *RhtB1b* from the wheat cultivars *Fundulea 133*, *Flamura 85*, *Dropia* etc. was of crucial importance for creating new intensive triticale genotypes more resistant to lodging and with a higher efficiency of recover the nutrients necessary to develop profitable crops.

The triticale cultivars created based on the continuous genetic progres and breeding achievements are characterised by improved desirable agronomic traits and are competitive with other cereals less adapted to hilly regions, less fertile and acid soils. (Ittu et al., 2005, 2022). Between 2018-2023 were registered at NARDI Fundulea the new intensive triticale cultivars: *Utrifun* (2018), *Zori* and *Zvelt* (2020), *Zaraza* (2021), *FDL Ascendent* (2022) and *FDL Caltrit* (2024).

Paper presents the first released triticale cultivars *Drăgănești* and *Egreta* (2025), obtained at ARDS-Teleorman, following the primerly introduction of a triticale breeding program, based on germplasm transfer from NARDI-Fundulea (agronomic cycle 2019/2020).

MATERIAL AND METHODS

Are presented experimental data on the agronomic performances registered by the first triticale cultivars obtained at the triticale breeding program from ARDS-Teleorman, *Drăgănești* and *Egreta* (2025). Preliminary tests started in 2021 in nine environments and the main breeding objectives were to improve the agronomic type and resistance/tolerance to biotic and abiotic stresses.

Drăgănești is the result of complex recombinations focused on multiple resistance sources to pathogens and yield potential carried at ARDS Teleorman (Authors: Voica Maria, Delcea Alina Mihaela, Bălțatu Mariana, Tunaru Ioan, Ittu Gheorghe, Ittu Mariana and Marinciuc Cristina Mihaela).

Egreta (result of cross *Utrifun/Utrirom*) was obtained at ARDS-Teleorman (Authors: Voica Maria, Delcea Alina Mihaela, Bălțatu Mariana, Tunaru Ioan, Melucă Cristina, Ittu Gheorghe, Ittu Mariana and Marinciuc Cristina Mihaela).

Drăgănești and *Egreta* were registered in the National List of Cultivars in 2025.

Experimentations were performed in yield trials conducted at National Agricultural Research-Development Institute (NARDI) Fundulea (2022-2025), and the State Institute for Testing and Registration of Varieties (SITRV) (2022-2024).

The new triticale genotypes *Drăgănești* (14225T1-2) and *Egreta* (16026T4-1) were evaluated within the National Triticale Trial (NTT) between 2022-2025, coordinated by the National Agriculture Research and Development Institute (NARDI) Fundulea in 39 environments, including also other ten agricultural research development stations (ARDS), under the Academy of Agricultural and Forrest Sciences (AAFS). The testing sites were: ARDS Teleorman (44°07'N, 25°45'E), National Agriculture Research and Development Institute (NARDI) Fundulea (44°30'N, 26°51'E), ARDS Brăila (45°16'N, 27°57'E), ARDS Pitești (44°81'N, 24°86'E), ARDS Șimnic (44°20'N, 23°49'E), ARDS Lovrin (45°57'N, 20°46'E), ARDS Oradea (47°02'N, 21°54'E), ARDS Livada (47°52'N, 23°08'E), ARDS Turda (46°58' N, 23°78'E), Research and Development Station for Cattle Breeding (RDSCB) Târgu-Mureș (46°32'N, 24°33'E) and ARDS Secuieni (46°N, 26°86'E). These testing sites are representative for a large diversity of soils across Romania, from chernozem to luvisol with pH from 5.02 to 7.6, and humus content from 1.71 to 3.6%. Weather conditions during the period 2022-2025 at all sites reflected present climate changes and were

diverse, as illustrated by rainfall, which varied from 250 to 620 mm/year, optimally fertilized with P 40 kg s.a./ha and N 86 kg azot s.a./ha and in a suboptimal system (P40 kg s.a./ha, N 40 kg s.a./ha). The new triticale genotypes were compared to the previously released cultivars at NARDI Fundulea (*Zori*, *Zvelt*, *Utrifun*, *Zaraza*, *FDL Ascendent* and *FDL Caltrit*) and check cultivars *Haiduc* and *Utrifun*, also included in the yield trials of SITRV.

Experiments were conducted under field and artificial conditions focused on yield potential expressed as: grain weight (GW, kg/ha), thousand grain weight (TGW), test weight (TW, kg/hl), and grain quality coefficients (content of protein, starch and wet gluten).

Artificial tests were done for resistance to sprouting and Fusarium head blight (FHB) at NARDI Fundulea. Evaluation of resistance to FHB was based on field artificial point inoculation with two selected isolates for virulence, *Fusarium graminearum* (F.g. 96) and *Fusarium culmorum* (F.c. 46) (Ittu et al., 2006). The results were expressed as Area Under Disease Progress Curve (AUDPC), illustrating disease progress computed based on disease scores registered at 10 and 20 postinoculation days.

Resistance to pathogens *Septoria* and *Puccinia striiformis* (yellow rust, YR) was evaluated under natural field conditions.

Content of protein, starch and wet gluten was determined with the INFRATEC 1241 FOSS analyser, by spectroscopy technique (infrared).

Experimental data were analysed by ANOVA (Ceapoiu, 1968). Yield potential of ten cultivars was evaluated over four years in the same location, and simple correlations between the analysed agronomic traits were calculated.

Rain falls registered during experimental years varied as compared to multi year average, with an excess of 23 mm in fall (2021-2022) and a cumulative of 88 mm less in all phenopases. In 2022-2023, less 28 mm were registered in fall, while in winter and and stem elongation stage was an excess of 23 mm and less 41 mm during grain filling (milk and dough development), less water in all phenofases (2023-2024), optimal pluviometric regime (2024-2025) during preparation of the germinal bed, winter and intense growth stage and poor (minus 58 mm) grain filling (Table 1a).

The average temperatures overcome the multi-year average in all experimental years. (Table 1b) The very diverse pluviometric and temperatures regimes registered in the experimental period reported, were appropriate to a comparative evaluation of triticale genotypes under field conditions.

Table 1. Rainfall (mm)(a) and temperatures °C(b) registered under different vegetation stages at ARDS Teleorman (2022-2025)

a)

Years	Sowing and sprouting of plants (IX-XI)	Winter reserve (XII-III)	Intense growth-blooming (IV-V)	Grain filing (VI)
2021-2022	147.4(+23.1)	104(-39.3)	95(-8)	36.5(-35.9)
2022-2023	96(-28.3)	163(+19.7)	109(+6)	31(-41.4)
2023-2024	104(-20,3)	127(-16)	66(-37)	22(-50,4)
2024-2025	140(+15,7)	233(+90)	117(+14)	14(-58,4)
<i>Multi-year-average</i>	<i>124.3</i>	<i>143</i>	<i>103</i>	<i>72.4</i>

b)

Climatic factor	Month									
	IX	X	XI	XII	I	II	III	IV	V	VI
Average temperature during the month multi year (°C)	18	11.6	4.4	-0.3	-3.3	-0.5	4.6	11.9	16.8	20,6
Deviation										
2021-2022	+0.5	-1.2	+2.9	+2.4	+4.8	+4.9	-0.6	-0.5	+1.2	+2,4
2022-2023	+0.9	+2.5	+4.4	+3.2	+7.6	+4.1	+3.3	-0.8	-0.6	+1,3
2023-2024	+4,4	+5,4	+4,6	+4,3	+4,4	+8,3	+4	+3,2	-0,2	+5,2
2024-2025	+1,2	+1,7	+1,3	+3	+6,2	-1,9	+2,3	+1,1	-1,1	+2,7
<i>Average</i>	<i>+1,75</i>	<i>+2,1</i>	<i>+3,3</i>	<i>+3,23</i>	<i>+5,75</i>	<i>+3,85</i>	<i>+2,25</i>	<i>+0,75</i>	<i>-0,2</i>	<i>+0,08</i>

RESULTS AND DISCUSSION

Morphologic traits

Drăgănești - has an intermediate to semi-recumbent canopy during twinning, waxy sheath and back blade of flag leaf, short to medium straws, yellow-reddish, pyramidal shape and medium size ears, entirely awned (medium to long) with lying down position at maturity, medium size and elongated kernels, red coloured, TKW: 45-50 g and TW: 75-76 kg/hl in optimal conditions, earliness.

Egreta - intermediate canopy during twinning, waxy sheath and back blade of flag

leaf, short straw, medium to intense yellow, pyramidal shape, medium size, totally awned (short size and lying down at maturity), medium size and oval kernels, red colour, TKW: 44-50 g and TW: 75-76 kg/hl under optimal conditions, medium earliness.

Physiologic traits

In trials accomplished at SITRV, heading of triticale *Drăgănești* occurred earlier as compared to the check cultivars, but the vegetation period is comparable to that of Haiduc, while *Egreta* has medium earliness being more similar to Utrifun (Table 2).

Table 2. Vegetation period of *Drăgănești* and *Egreta* cultivars, as compared to the check cultivars, SITRV, six conditions mean values, 2022-2024

Year	Sprouting - heading (days)				Differences from checks			
	Haiduc (check 1)	Utrifun (check 2)	Drăgănești	Egreta	Drăgănești		Egreta	
					Haiduc	Utrifun	Haiduc	Utrifun
Sprouting-heading (days)								
2022	200	-	200	201	0	-	+1	-
2023	206	209	205	207	-1	-4	+1	-2
2024	193	195	192	193	-1	-3	0	-2
Heading-ripening(days)								
2022	52	-	52	53	0	-	+1	-
2023	56	54	56	56	0	-2	0	-2
2024	56	56	57	58	+1	+1	+2	+2
Sprouting-ripening(days)								
2022	252	-	252	254	0	-	+2	-
2023	262	263	261	263	-1	-2	+1	0
2024	249	251	249	251	0	-2	+2	0

In trials carried on at ARDS Teleorman in period 2022-2025, heading of cultivar *Drăgănești* occurred four days before the both

check cultivars, but earliness of *Egreta* was comparable to *Utrifun* (Table 3).

Table 3. Vegetation period of cultivars *Drăgănești* and *Egreta* as compared to two check cultivars, ARDS Teleorman, 2022-2025, mean values

Year	Number of days (from sprouting to heading)			
	Haiduc (check 1)	Utrifun (check 2)	Drăgănești	Egreta
2022	182	185	181	184
2023	152	154	151	154
2024	133	134	128	133
2025	148	149	145	148

Resistance to pathogens

Fusarium head blight (FHB). Artificial inoculations performed with FHB at NARDI Fundulea revealed lower values, on average, for Area Under Disease Progress (AUDPC) of cultivars *Drăgănești* (AUDPC: 87.66) and

Egreta (AUDPC: 131.39), as compared to those found in check cultivars *Utrifun* (AUDPC: 229.5) and *Haiduc* (AUDPC:136.05). The both cultivars *Drăgănești* and *Egreta* expressed a medium level of resistance to YR and septoriosis,

these attacks being prevalent at the end of vegetation period while their resistance to

sprouting represents a progress, as compared to checks (Table 4).

Table 4. Reaction to FHB and sprouting of the grains from the ear (NARDI Fundulea, 2023), YR and septoriosis (ARDS Teleorman, 2022-2024)

Cultivar	Trait			
	FHB, AUDPC (2023)	YR, (1-10)	Septoriosis, (1-10)	Sprouting, (1-10)
Stil	91.30	3	4	1
Haiduc (Mt1)	136.05	6	4	2
Utrifun (Mt2)	229.5	6	3	3
Zori	139.34	3	2	1
Zvelt	60.00	4	3	1
Zaraza	295.28	2	2	1
FDL Ascendent	180.7	4	2	2
FDL Caltrit	123.24	4	3	3
Drăgănești (14225T1-02)	87.66	3	3	1
Egreta (16026T4-1)	131.39	2	3	2

Yield potential. In trials conducted by SITRV, evaluation of yield potential in period 2022-2024, revealed increased yields by 13% and 9%, respectively in *Drăgănești* and *Egreta*, over these of *Haiduc* and *Utrifun* (checks). The total yield registered, on average,

in 18 environments was of 7934 kg/ha in *Drăgănești* (Figures 1a and 1b), and of 7630 kg/ha in *Egreta* (Figures 2a and 2b), while yields of *Haiduc* and *Utrifun* were of 7139 kg/ha and 7105 kg/ha, respectively.

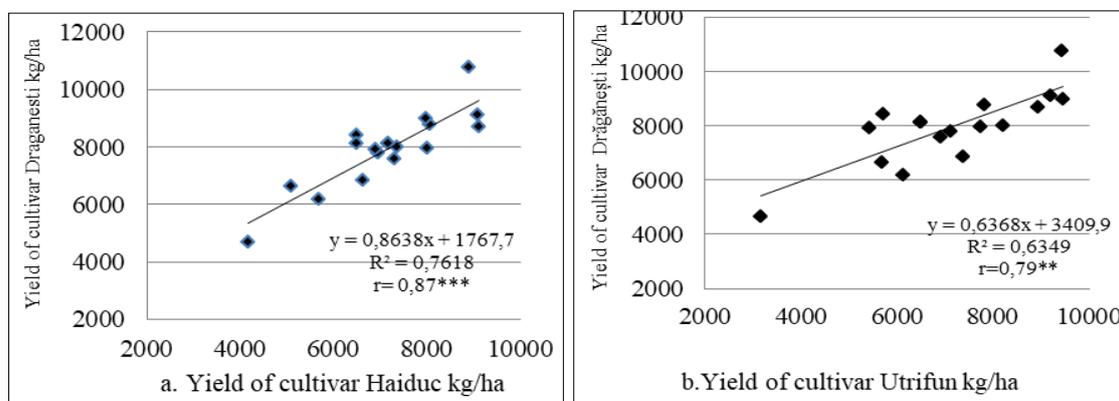


Figure 1. Comparison between grain yield of *Drăgănești* and that of the check cultivars *Haiduc* (a) and *Utrifun* (b), SITRV, 2022-2024

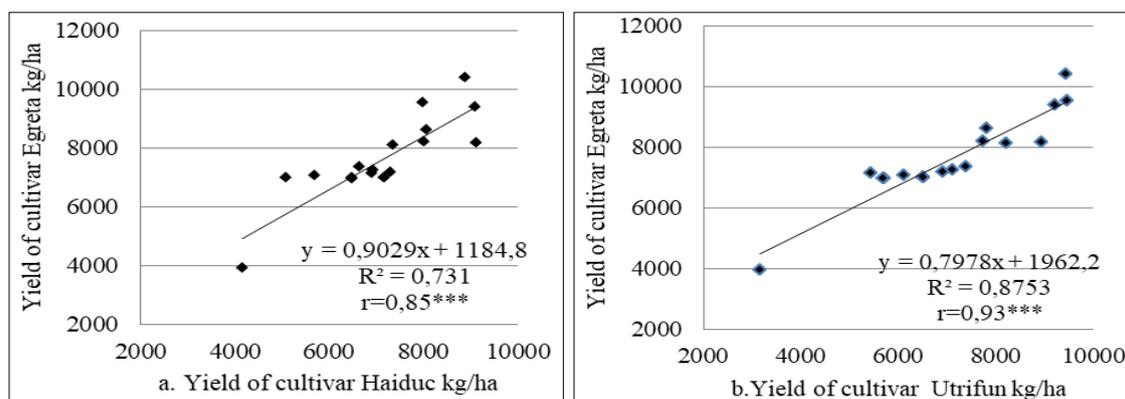


Figure 2. Comparison between grain yield of *Egreta* and that of the check cultivars *Haiduc*(a) and *Utrifun* (b), SITRV, 2022-2024

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In trials of SITRV, values of TGW recorded for *Drăgănești* and *Egreta*, were lower therefore of check Haiduc, but were rather similar to Utrifun. Test weight (TW) of *Drăgănești* and *Egreta* was overall higher

relative to checks. The lower yield of cultivar *Drăgănești* was 4674 kg/ha, and, respectively 3939 kg/ha for cultivar *Egreta* (Rădăuți, 2022) (Table 5).

Table 5. Yields, TKW and TW of triticale cultivars *Drăgănești* and *Egreta*, as compared to check cultivars, SITRV, 2022-2024

Cultivar	Yield/location/year (kg/ha)							Average/yr (kg/ha)	%	TKW (g)	TW (kg/hl)
	Anul	Dej	Rădăuți	Roșiorii de Vede	Satu Mare	Târgu Secuiesc	Târgoviște				
Haiduc	2022	8895	4158	8062	9091	9107	6941	7709	104	49	72
	2023	6488	6480	7356	8004	7178	6626	7022	100	47	73
	2024	6898	7290	7975	5081	7178	5687	6685	100	46	71
	<i>average/location</i>	7427	5976	7798	7392	7821	6418	7139	101	47	72
Stil	2022	9441	3170	7811	9209	8949	7122	7617	100	47	73
Utrifun	2023	5710	6505	8208	7741	6505	7389	7010	100	47	74
	2024	5432	6913	9466	5685	6505	6127	6688	101	44	73
	<i>average/location</i>	6861	5529	8495	7545	7320	6879	7105	100	46	73
Drăgănești	2022	10778	4674	8792	9130	8698	7798	8312	113	48	75
	2023	8414	8126	8013	7956	8126	6843	7913	113	45	75
	2024	7926	7583	8995	6652	8126	6183	7578	114	45	74
	<i>average/location</i>	9039	6794	8600	7913	8317	6941	7934	113	46	75
Egreta	2022	10415	3939	8615	9386	8180	7244	7963	107	45	74
	2023	6974	6994	8119	8221	6994	7370	7445	106	45	75
	2024	7137	7172	9536	6988	6994	7069	7483	113	44	74
	<i>average/location</i>	8175	6035	8757	8198	7389	7228	7630	109	45	74

The highest yields obtained from cultivars *Drăgănești* and *Egreta* are presented in Table 6. Were registered yields higher than 8 t/ha, on average, in four (*Egreta*) and five (*Drăgănești*) of six locations. Averaged

differences from Haiduc were of 414 kg/ha (*Egreta*) and 652 kg/ha (*Drăgănești*). The highest yield, was recorded in location Dej (10778 kg/ha, year 2022).

Table 6. Maximum yields of the new triticale cultivars *Drăgănești* and *Egreta* (differences from Haiduc, SITRV, 2022-2024, kg/ha)

Location	Year	Haiduc, control	Drăgănești		Egreta	
			abs	diff.	abs	diff.
Dej	2022	8895	10778	+1883	10415	+1550
Satu Mare	2022	9091	9130	+39	9386	+295
Târgu Secuiesc	2022	9107	8698	-409	8180	-927
Târgoviște	2023	6626	7798	+1172	7370	+744
Rădăuți	2024	7920	8126	+206	7172	-740
Roșiorii de Vede	2024	7975	8995	+1020	9536	+1561
<i>Average</i>		8269	8921	652	8677	414

In trials performed under AASF, average yield registered over 39 environments, was 7200 Kg/ha in *Drăgănești* (Figures 3a and 3b), and 7100 kg/ha in *Egreta* (Figures 4a

and 4b), while yields of checks ranked between 6044 kg/ha (*Haiduc*) and 6900 kg/ha (*Utrifun*).

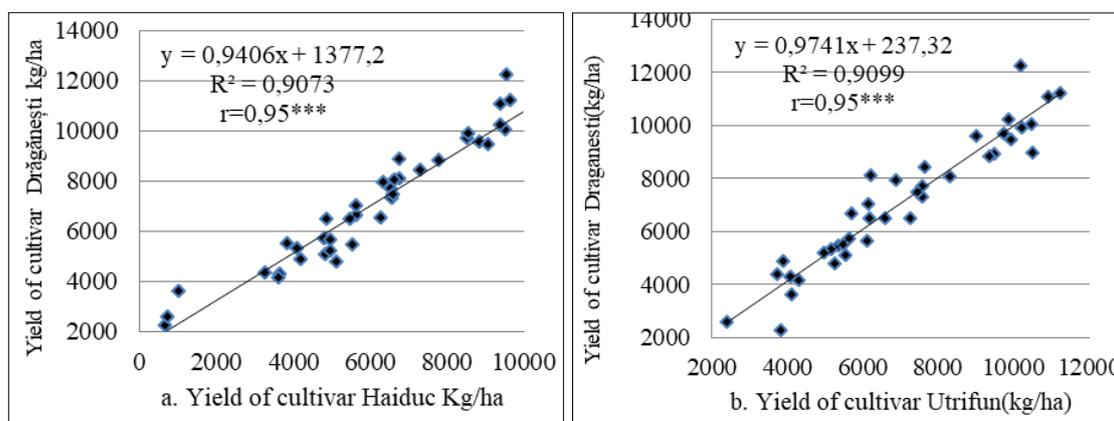


Figure 3. Comparison between yield of cultivar *Drăgănești* and that of the check cultivars *Haiduc* (a) and *Utrifun* (b), 39 environments, AASF, 2022-2025

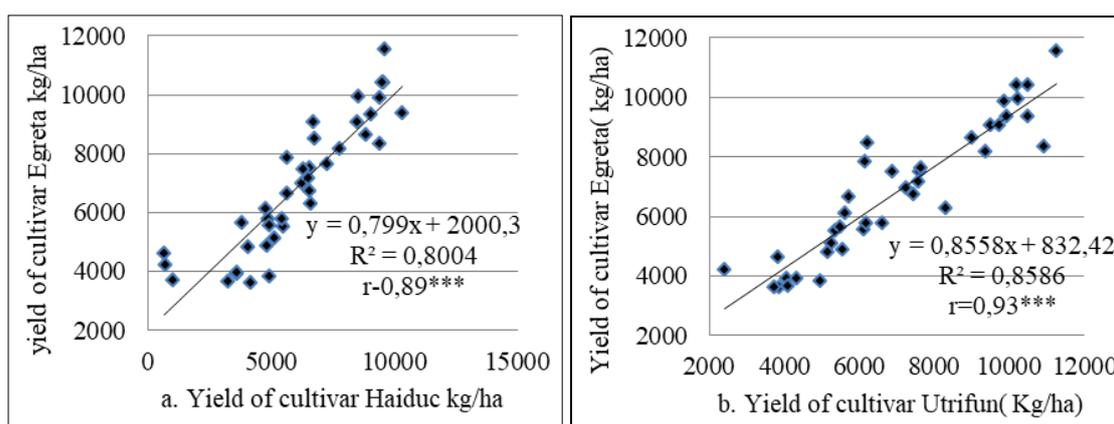


Figure 4. Comparison between yield of cultivar *Egreta* and that of the check cultivars *Haiduc* (a) and *Utrifun* (b), 39 environments, AASF, 2022-2025

In field trials conducted at ARDS Teleorman from 2022 to 2025, including 10 Romanian triticale cultivars, the new released registered significant higher yields comparative to checks, ranking from 277* to 922*** (*Drăgănești*) and, respectively from 259* to 920*** (*Egreta*). Lower yields were

found on average under severe drought conditions registered in 2024 (5421 kg/ha), and accordingly, the highest ones were obtained in 2025 (9691 kg/ha), considered with a few exceptions very favorable for cereal crops (Table 7).

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Table 7. Yield of winter triticale cultivars, compared to cultivar Utrifun, ARDS Teleorman, 2022-2025

Cultivar	2022		2023		2024		2025		Average	
	kg/ha	Diff. check	kg/ha	Diff. check	kg/ha	Diff. check	kg/ha	Diff. check	Diff. check	Diff. check
Utrifun (check)	5644	0	5727	0	5162	0	9873	-5	6602	0
Stil	5009	-635 ^{ooo}	5929	202	4865	-297	9400	-478 ^{oo}	6301	-301 ^o
Haiduc	4810	-834 ^{ooo}	5639	-88	4096	-1066 ^{ooo}	9384	-494 ^{oo}	5982	-620 ^{ooo}
Zori	5700	56	6549	822 ^{**}	5115	-47	9730	-148	6774	172
Zvelt	6011	367 [*]	5954	227	5035	-127	9715	-163	6679	77
Zaraza	5497	-147	6236	509 [*]	5563	401 ^{**}	10214	336 [*]	6878	276 [*]
FDL Ascendent	5949	305 [*]	6427	700 [*]	5284	122	9016	-862 ^{ooo}	6669	67
FDL Caltrit	5426	-218	6801	1074 ^{***}	4531	-631 ^{ooo}	9367	-511 ^{oo}	6531	-71
14225T1-02 (Drăgănești)	5921	277 [*]	6649	922 ^{***}	5502	340 ^{**}	10229	351 [*]	7075	473 ^{***}
16026T4-1 (Egreta)	6129	485 ^{***}	6647	920 ^{***}	5421	259 [*]	9977	99	7044	442 ^{***}
Average	5610		6256		5047		9691		6654	
DL5% kg/ha		260,1		508,8		243,2		308,6		270,1
DL1% kg/ha		380,5		737,5		320,0		456,9		342, 2
DL 0.1% kg/ha		470,3		915,2		412		520,03		450,5

Under conditions of ARDS Teleorman, although grain yields obtained under the suboptimal fertilization system (N40:P40 kg s.a./ha) were higher in comparison to the optimal one (N86:P40 s.a./ha), differences of yield registered by Utrifun were superior by 270 kg/ha in *Egreta* and 221 kg/ha in *Drăgănești*. Higher yields were also registered for the new triticale in trials performed under AAFS, where, in contrast, fertilization with N86:P40 kg s.a./ha was associated to higher

grain yields (Table 8).

The high yield potential and adaptability of the newly registered cultivars *Drăgănești* and *Egreta* were further confirmed across diverse environments in SITRV, where average yield of 7934 kg/ha (*Drăgănești*) and 7630 kg/ha (*Egreta*), respectively, were obtained. In comparison, the check cultivars Haiduc and Utrifun recorded mean yields ranging from 7105 kg/ha to 7139 kg/ha, respectively (*data not shown*).

Table 8. Differences of yields registered for nine triticale cultivars in comparison to Utrifun in optim and suboptim N systems (kg/ha), 55 environments

Variety	Cultivars	Difference of Utrifun (kg/ha)			
		ARDS Teleorman (4 conditions, 2022-2025)		AAFS (51 conditions, 2022-2025)	
		N optim	N suboptim	N optim (39 conditions, 2022-2025)	N suboptim (12 conditions, 2022-2025)
	<i>Utrifun (check)</i>	6602	6970	6890	5808
1	Stil	-301	-251	-739	-568
2	Haiduc	-620	-570	-846	-661
3	Zori	172	5	-450	-371
4	Zvelt	77	8	-363	-55
5	Zaraza	276	219	181	25
6	FDL Ascendent	67	348	-149	110
7	FDL Caltrit	-71	-148	-153	29
8	Drăgănești	473	221	327	57
9	Egreta	442	270	181	55

Quality parameters. Analyses of protein, starch and wet gluten, revealed in 2023 and 2024, the optimal level of quality of the new triticale entries *Drăgănești* and *Egreta*,

comparable to the control cultivars, Haiduc and Utrifun, confirming the suitability of the new entries in terms of grain quality (Figures 5a and 5b).

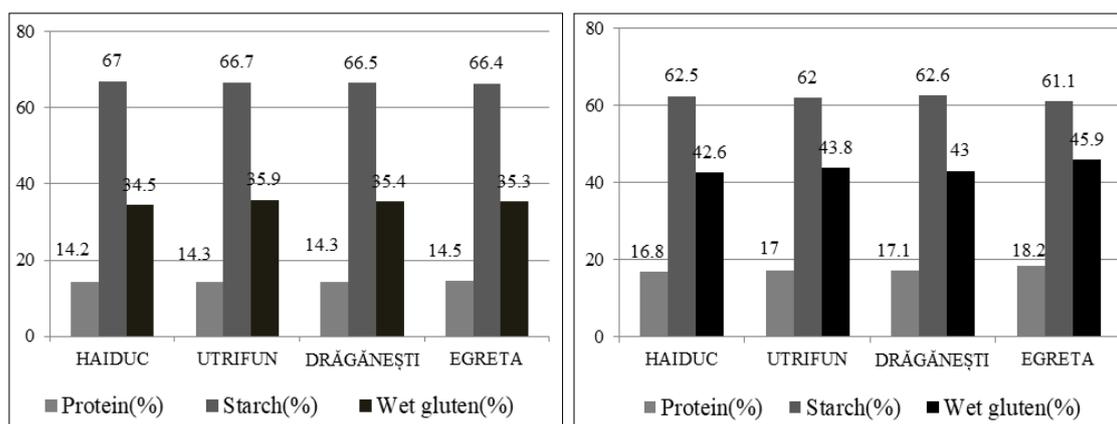


Figure 5. Protein, starch and wet gluten contents, 2023 (a) and 2024 (b)

CONCLUSIONS

The triticale cultivars *Drăgănești* and *Egreta* represent significant progress in triticale breeding, combining high yield potential with enhanced resistance to diseases and improved tolerance to pre-harvest grain sprouting.

The good level of adaptability found in both cultivars, recommend to be cultivated in country wide environments, in order to increase grain yield and to diversify the local crop structure.

Further approaches will aim to improve the breeding methods and diversification of triticale genetic resources.

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