TRITICALE IMPROVEMENT: PROBLEMS AND PROSPECTS IN THE WEST PART OF ROMANIA

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Abstract. *The paper highlights the progress in triticale crop becoming an important economically cereal in the world and also in the West part of Romania. The international research stimulated the Romanian triticale program in research centers Fundulea, Turda, Suceava and Timişoara University. The extension of the results from the demonstration fields was difficult; the optics of the farmers from a traditionally wheat-growing country had to be changed. Particular merits have had the specialists who, as students, saw and worked in the triticale experimental fields at the university, thus convincing themselves of its validity. In the western counties of Romania triticale represents 1.56% of agriculture area. It is cultivated on poorly acid soils and in farms with livestock sections. The area cultivated with triticale varies greatly. In the southern counties of Arad, Bihor and Timiş the surface represents 1.0% -1.5%. In Caraş Severin and in the northern counties it is 2.5% to 5.1% (Sălaj). On preluvi- and luvi- soils (pH-4.5) distrycambosoils, arenosoils (humus less than 2.2 %) the yield was 2.6 T/ha up to 4.5 T/ha, exceeding wheat and in some areas even corn. In the plain with more fertile soils (chernozem) the Robinson, Trimaso, Trismart and Tulus varieties passed over 9.0 T/ha* (2021). *The triticale average production/country increased from 2.5 T/ha (2007) to over 3.4 T/ha in the past 10 years and now to 4.6 T/ha. Most of the cultivated varieties originated from the Fundulea (Dr. Gh. Ittu). Farmers in the western part of Romania appreciate triticales, but they also have certain grievances that breeders strive to correct.*

Keywords: Triticale cultivation, Romania West Part

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1. Introduction

Triticale is a gamble with time, with us to perform something that seemed to be impossible [9]. For the senior researchers, it is a delight to see their hope and efforts fulfilled. Great triticalists as Charles Jenkins (†2000), Robert Glen Anderson (1914-1982), Arpad Kiss (1916-2001), Robin Jessop (†2021), Bent Skovmand (1945-2007), Tadeusz Wolski (1924-2005), Enrique Sanchez-Monge (1921-2010) lost the battle with the time. We think of them with gratitude and respect, and we know that every success today is part of their hard pioneer work.

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Between wheat and rye on the one hand, and triticale on the other, it was a competition for high productions and respectively for recognition among cereals.

In 1972, when I submitted a line of triticale for patenting, *The State Institute for Testing and Registration of Varieties-Romania* (I.S.T.I.S.) did not know who to compare it with? With wheat or with rye? It was chose wheat. Naturally, triticale line couldn't be at least 10% upper than the production of the Bezostaia 1 variety.
Since the beginning of this century, genetic progress in wheat has slowed, which means that genetic variability has reached a maximum [1, 14, 3, 8, 11] the threshold that would could be overcome by improving the plant phenotype [2, 5], due to increasing the crop growing season [17, 6, 12] more fertile flowers/spikelet, as well as a high availability of photosynthesis products [16, 20, 19, 13].

Triticale meets all these requirements: robust phenotype [15, 18], large ears with 5-9 flowers in spikelet of which 4 are fertile with normal grains. Thus triticale has become a source of widening of genetic variability in wheat [9].
If initially it was only in the attention of researchers, and many years has been the "object of study" today great concerns around the world launch new and better triticale varieties.

In the western part of Romania, along with the Romanian varieties created at Fundulea (Dr. Gh. Ittu) are very popular other varieties created by large international companies such as Donau Saat and Nordsaat Saatzucht GmbH from Germany or RWA Raiffeisen Ware Austria AG (RWA). An extent cooperation, the exchange of information and seeds it is the key to today's success.

To find ecological niches where triticale could express its genetic potential and in the same time to create confidence among students and farmers was our main concern. For this there were requested triticale collections from CIMMYT (6x; 1981), EUCARPIA (6x; 1981), Canada (6x, 1972), Hungary (6x; 1975), USSR (6x and 8x; 1977) and from China (8x; 1988). This activity is objectified in specialists who were trained at our university who, through the information and convey seeds, extended the triticale culture [4].

The purpose
The aim of this paper is to present the scientific progress accumulated in the new triticale varieties, taking into account the global and national trend and the interest of farmers for cultivation (as grains, as fodder, or industrialization).

2. Materials and Methods

Sources of information from the specialized literature, from the Romanian Ministry of Agriculture and Domains (MADR), Triticale World-Dashboard

(2007-2019) and TEMPO online database (2007-2020) were used. Data from the western part of Romania were collected by the method of straw vote.

In graphs are the data summarized.

3. Results and Discussions

The knowledge result about triticale

The CIMMYT initiative to organize the Triticale International Symposium led to a breeding program ***to produce a new food crop which will be superior .... to all other cereal grains, particularly for those grown in food-deficient areas*** [10]. It was the moment that opened the way for systematically studies for practical purposes.

For a decade, meetings of pioneer triticalists were organized. The 299 presenters were from all continents and their countries: 5 from Africa, 4 and 2 from North and South America respectively, 2 of Asia, 20 from Europe and Australia. These pointed out the interest to obtain, to know and to diversify the triticale cultivars.

ITA (*International Triticale Association*) was initially proposed at the first International Triticale Symposium at Sydney University by the late Norman Darvey and others in 1986. Formal ratification and international support was validated at the Eucarpia Triticale meeting in Schwerin in 1987.

The reference work of B.Ch. Jenskins, E. Larter, A. Kiss, A.F. Shulyndin, A. Muntzing, T. Wolski, F.J. Zellinsky, D. Kolev, E. Sanchez-Monge, P. Gustafson, K.B. Porter, R.A. Anderson marked the triticale way to the future.

The results around the world

The measurable results from the breeders are visible in the surface and the world production but especially in the triticale export. The favorable biological peculiarities of triticale cultivars made them to be tested or even cultivated on all continents and in almost all countries (Fig. 1).

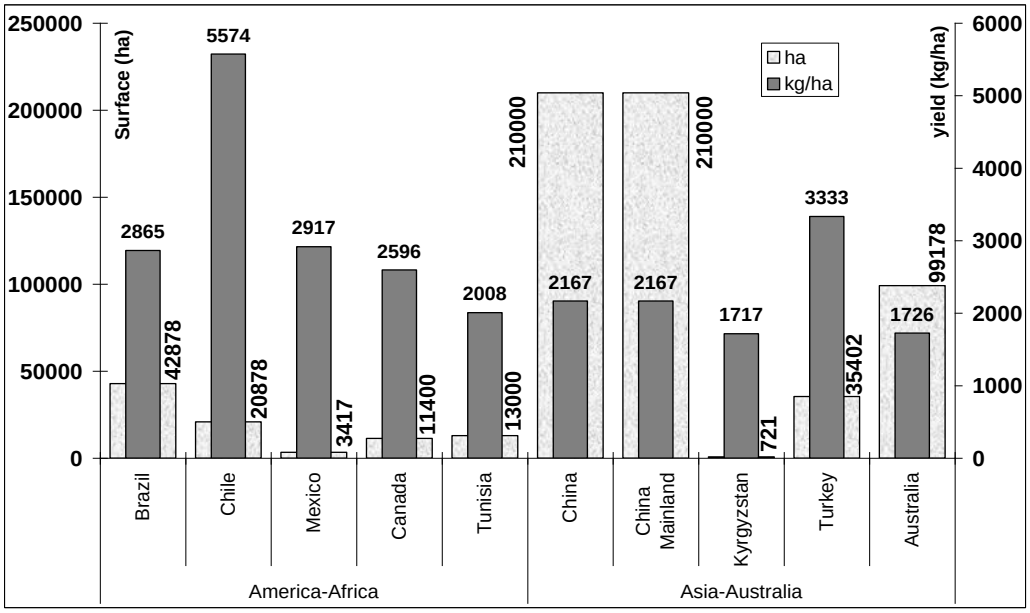

Fig.1. Worldwide triticale area (ha) and yield (kg/ha) in different continents (2013)

The best productions were obtained in the North and South American continents. In first place was Chile with 5.57 T/ha followed by Mexico (2.9 T/ha), Brazil and Canada with yields over 2.5 T/ha.

The continents located east of Romania had small productions. In China as in Australia the production was 2.17 T/ha and 1.73 T/ha, respectively. If we consider the climate conditions of them and especially their use in animal feed as green fodder, it is understandable the small grain production which was not a main breeding objective.

The productions of Turkey and Kyrgyzstan located in quite similar areas in terms of environmental conditions are very different being 3.33 T/ha and 1.72 T/ha, respectively. In Turkey the role of the experimental center from Ankara (Turkey and ICARDA collaboration) was decisive for a favorable evolution of triticales.

The evolution of the quantity (Qty) of triticale seed in the top 10 countries in World (2015-2020)

The Qty chart shows the decline of triticale cultivation in the world (Fig. 2).

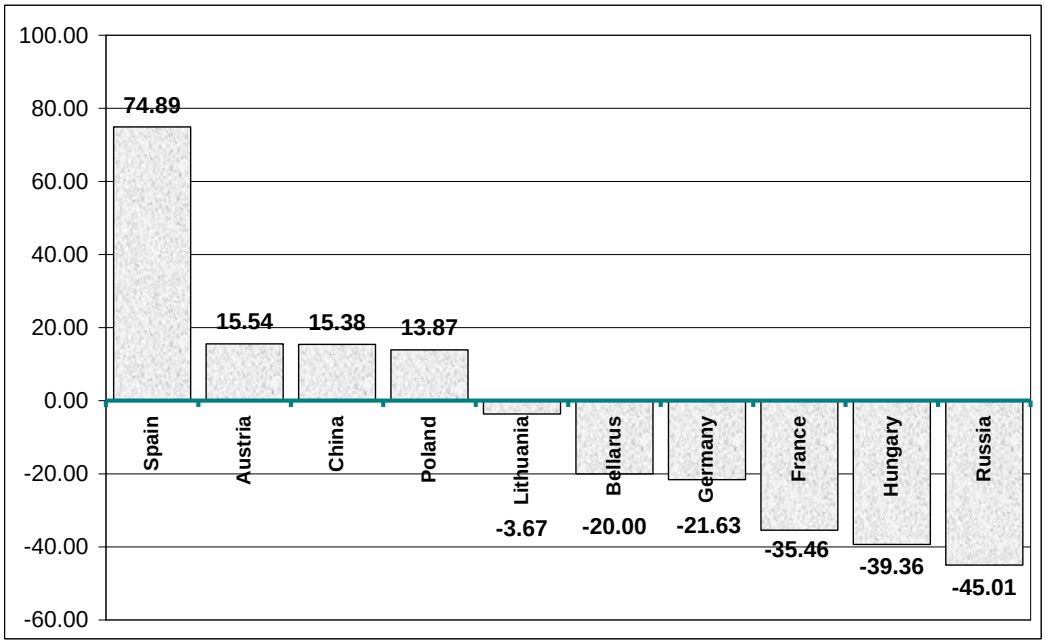

Fig.2. 5-year yield growth (Qty.) in the world's leading triticale-producing countries (2015-2020)
Triticale World-DASHBOARD

Of the top 10 major triticale-growing countries, in only 30% of them the production has increased (Spain, Austria, China and Poland). In the remaining 70% countries the decline in production was from -6.67% to -74.89% in Lithuania to Russia respectively. This regression may be caused by low genetic progress or the animal herds diminish.

From the countries that organized international scientific events during the period 1973-1984 in triticale top 10 of 2020 are Poland, France and Russia.

Cultivation of triticales in Europe

In Europe, most triticale-growing countries are in the eastern part (53.57%; Fig.3).

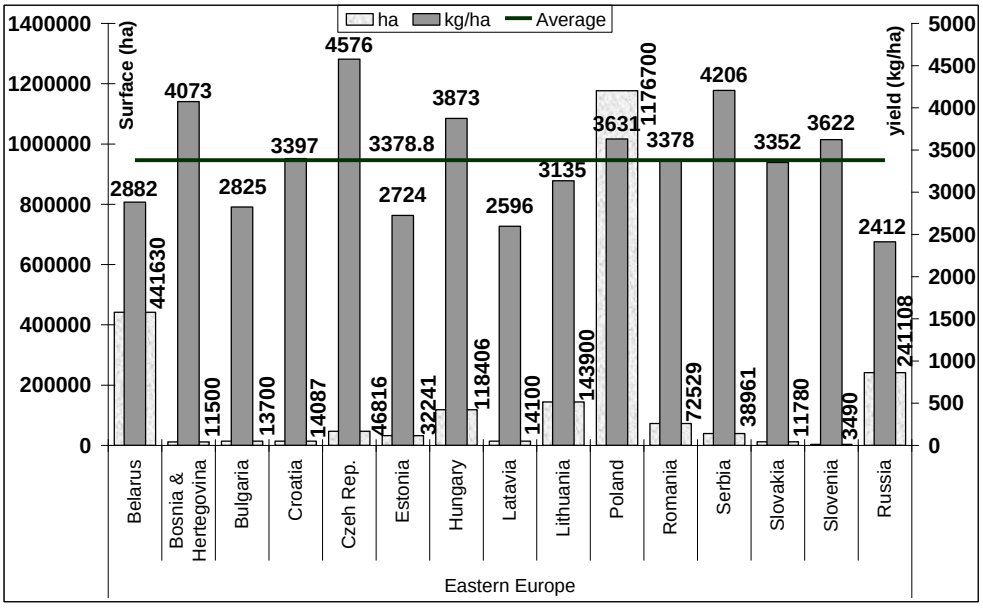

Fig. 3. The triticale cultivated area (ha) and yield average (kg/ha) in East part of Europe (2013) Triticale World-DASHBOARD

In this geographical area there were and are old centers for the study and breeding of triticale (Hungary, Poland and Russia). Today, in addition to the 3 triticale exporting countries, there are 11 others, including Romania.

The classification of Eastern European countries according to the obtained productions shows that there are 3 countries (20% from all, Czech Republic, Serbia and Bosnia & Herzegovina) in which the production exceeds 4.0 T/ha; on 33% of them the yield was lower than 3.0 T/ha; the remaining 47% yielded around 3.0 T/ha.

Taking into account the countries of Western Europe (Fig. 4), we see that the productions vary extremely much from over 7.0 T/ha (Belgium) to 1.15 T/ha (Greece).

Triticale production in Germany is also performing well, with the average production in 2013 being 6.57 T/ha, only 477 kg/ha lower than production in Belgium.

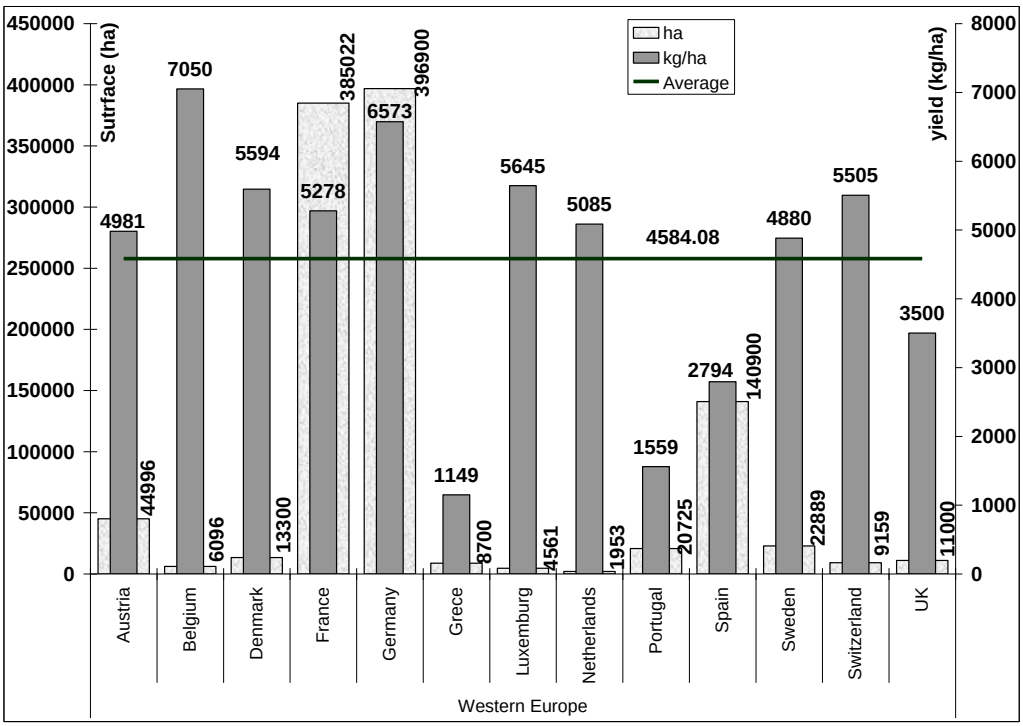

Fig. 4. The triticale area (ha) and yield average (kg/ha) in Western countries of Europe (2013) Triticale World-DASHBOARD

Of Western European countries 38% had good yield over 5.0 T/ha. Among them, Luxembourg and Denmark had yields higher than 5.5 T/ha, 15% had yields above 4.0 T/ha and 31% had lower yields from 3.5 T/ha (UK) to 1.15 T/ha (Greece).
Considering the total production (Metric Ton) recorded, it varied 156 to 6,079,980 MT. Most countries have production volumes of less than 100,000 MT (52.5%).
Some countries 27.5% have productions between 100,000 MT and 500,000 MT. Only Poland and Germany had higher productions (6,079,980 and 2,036,300 MT, respectively). Large productions in Poland and Germany are the result of environmental and social demands associated with a solid research program.
Austria Germany and Italy provided the most important seed base for large crops from Romania.

Romania as a breeder, cultivator and exporter of triticale

Romania is by excellence a cereal grower. The top species are soft and hard wheat, barley, 2-row barley and to a lesser extent, in specific ecological niches, rye is cultivated and in mountains Einkorn (*T. monococcum ssp monococcum)* is also cultivated.
From 2007 until now, the ameliorative progress in Romania is quantified by the total quantity of cereals which has constantly increased in recent years (Fig. 5).

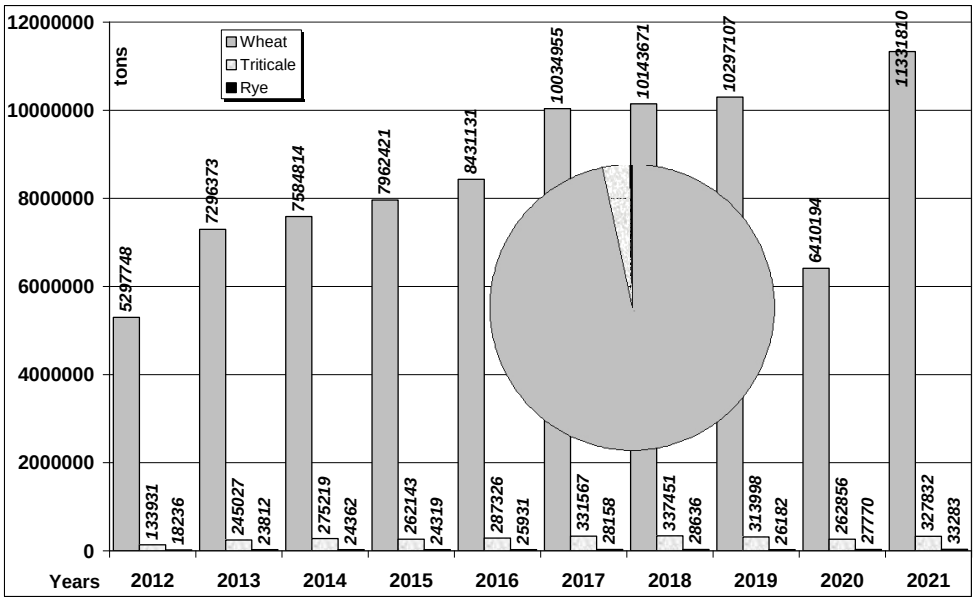

Fig.5. The total yield harvested in Romania during 2012-2021 to wheat triticale and rye (Tones)

Thus, wheat delivered with 272% more; triticale and rye increased 301% and 62%, respectively. Other cereals such as barley and 2-row barley the total quantity increased by 713% and 72.6%, respectively. Growers' interest in oats was low, decreasing by 86%.

The tradition and customs as well as market demand are unfavorable factors for the cultivation of triticale. And yet in these unfavorable conditions, triticale is slowly but surely gaining ground in Romania's economy.

The average yield of wheat, triticale, and rye over a period of 10 years

In 2021 the comparison among wheat rye and triticale pointed out the wheat superiority (5.3 T/ha) followed closely by triticale (4.67 T/ha) and rye performed only 3.49 T/ha. For triticale the average production in the country has steadily increased (Fig. 6).

The introduction of more efficient varieties created at INCD Fundulea and those from abroad had yielded over 7.5 T/ha. In 2021 the Goran and Trimasso varieties grown in the western part of the country produced 8.5-9.5 T/ha.

Taken in account the yield of wheat, triticale and rye (Fig. 7) it is visible the small difference between wheat and triticale (d=-673 kg/ha) and a large difference among rye and the both (d_{R-W}=-1.85 T/ha and d_{S-T}=-1.18 T/ha respectively).

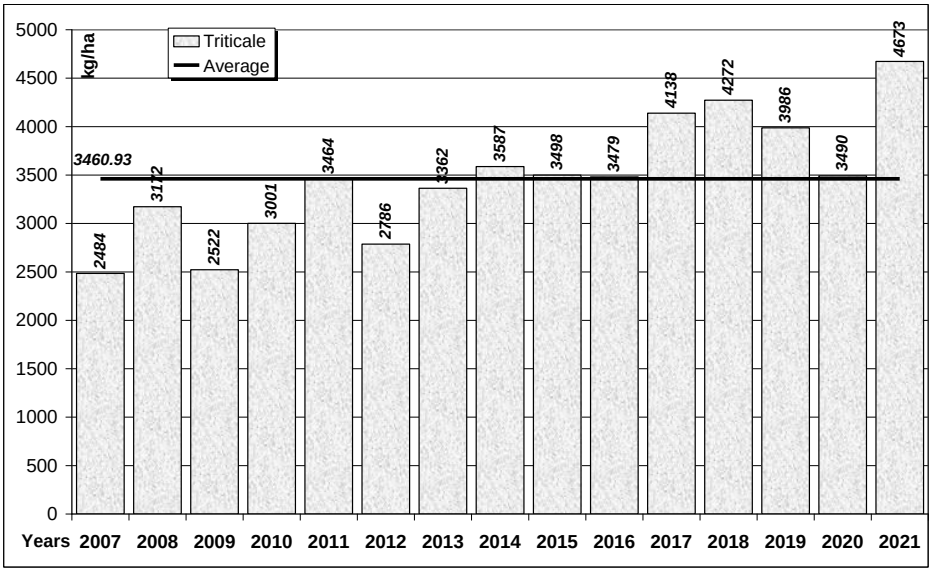

Fig. 6. Average production of triticale in the period 2007-2021
Source: TEMPO online database (2007-2020) and for the year 2021 MADR / August 16, 2021.

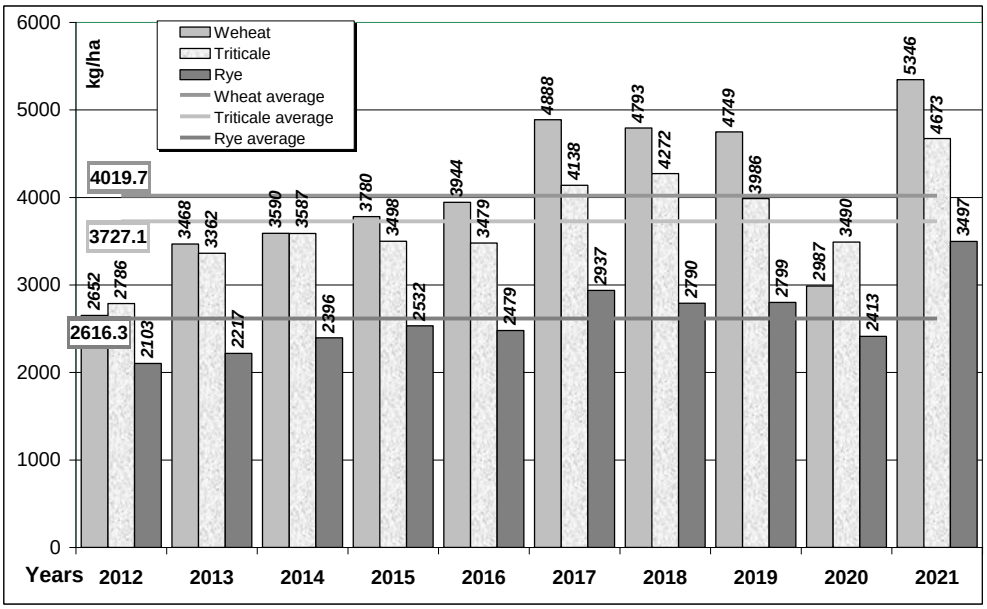

Fig. 7. Comparisons between average wheat, triticale and rye yield in the period 2012-2021
Source: TEMPO online database (2007-2020) and for the year 2021 MADR / August 16, 2021

Of the 10 years in 2 years (2012 and 2020) triticale exceeded wheat production, was close to wheat production in another 2 years (2013 and 2014), and in the remaining years the yields were lower by 282 kg/ha (2015) reaching the difference of over 750 kg/ha (2017 and 2019).
Fluctuations of production show that the genetic basis and triticale breeding programs are well and suitable, and that in extreme conditions (frost and drought) the yield capacity being higher than wheat (2020) aspects highlighted by cultivators of Bihor County (A. Feher and M. Rat). For our purpose our research was conducted under two different cultivation systems: experimental fields (3 areas) and commercial cultures (in 6 counties). There were used our breaded genotypes lines created at Timişoara Agronomic Institute (TAI) and at NARDI Fundulea.
In the farms, as commercial crops are cultivated varieties from Romania and from abroad.

Experimental fields
At TAI were developed several lines of triticale [T.Tim 6 (1974); T.Tim 7 (1975); T-1123/77; T-4586/79], but the most important action was to contribute to the awareness of the importance of triticale cultivation in Romania. The first monograph on triticale in the world was printed in 1985 [7].
The experimental fields were organized as follows: in Timişoara, Făget, and Gărâna with 1 ha and 0.5&0.5 ha, respectively. The locations were at different altitudes: 89 m., 145 m. and 1,000 m. above sea level. The soils were chernozem, preluvisoil with excess of Al^{+3} and distrycamosoil with 4.8 and 5.2 pH respectively at the lasts. The results obtained over 5 years showed the net superiority of all triticale genotypes over rye and some of them over wheat.
The extension results from Gărâna and New Brebu from 1978 in the area where rye was replaced with triticale. The manager of the Agricultural Directorate Caraş Severin eng. N. Ciorman (graduate of the IA Timişoara) in 1985 introduced triticale in the whole county both in the Collective Agricultural Farms and in the State Agricultural Enterprises. Until 2020 the area cultivated with triticale in Caraş Severin County varied among 1200-1300 ha being much for a mountain county with a small area of plain (7.3%).

Commercial cultures of triticale
In our investigations related to the cultivation of triticale in the western part of Romania, the information held by the Agricultural Directorates of the counties of Caraş Severin (Eng. Alina Bate), Timis (Eng. G. Ilas), Arad (Eng. Dr. I. Martin), Hunedoara (Eng. C. Grama), Bihor (Eng. A Huniadi), Satu Mare (Eng. I. Cioltean) and Sălaj (Eng. N. Dascal) were used.
The first varieties of triticale cultivated in almost all counties were Romanian varieties: TF2 (3.5-5 T/ha), Colina, Titan, Stil, Gorun, (breeder Dr. *Gh. Ittu*). The

currently grown varieties are Haiduc (5.5-7 T/ha), Negoiu (6-7.5 T/ha), Tulnic (6-7.5 T/ha), and Zvelt (7-8.5 T/ha) from Romania and from abroad are Goran (7.5-8.5 T/ha), Odisej (5-7.5 T/ha), Robinson (8.5-10 T/ha), Tarzan (7-7.5 T/ha), Tribonus (6.5-8.5 T/ha), Trimasso (7.5-9.5 T/ha), Trismart-Caussade (7-8 T/ha), Toulouse (6.5-8.5 T/ha).

In the following we present edifying data for each county presented by officials but especially by farmers.

We start this part with their commune opinions and the respondents' proposals for the following questions:

- "*What are the soils you recommend for growing triticale*?" Inevitably the answer was areas with poorer soils (100%), acidic, preluvisoil, arenosoil, gleysoils, luvisoils and distrycambosoil.
- "*What is the outlook for wheat on climate change*?" All the farmers interviewed, as well as the directors of the County Agricultural Directorates, emphasized the quality of triticale as *tolerant to adverse environment conditions due to drought and heat, and the quality* but especially of the Toulouse and Tribonus varieties which had excellent resistance.
- *"What are the benefits of triticale*?" Several advantages were mentioned, but the most significant were: excellent tolerance to the abiotic and biotic stress (diseases and pests, 12.6%), high and better secondary production that was used for silage or green mass or used as biomass (pellets or briquettes, 62.5%). The high grain yield, and especially for its quality, is an excellent feed for pigs and poultry (100%) but also to produce cereal distillates (6.25%). Early spring the triticale is used for sheep grazing and at the harvest there are 4.0-4.5 T/ha of grain. The benefit consists also in higher quality of wool. In the area of Caraș Severin and Sălaj there is an ameliorative soil culture and an excellent forerunner plant for corn.
- "*What suggestions and recommendations do you have for triticale breeders*"? Creating competitive varieties for different soil types (57.8%) to improve lodging resistance and sprouting tolerance (28.7%), increased protein content (35.7%). Resistance to biotic stressors should also be improved (61.5%).
- "*What is the prospect of triticale in the west part*? Due to poor legislation and marketing in 2022 in Bihor and Timis Counties the area cultivated with triticale has decreased. Also due to a defective legislation, small and middle farmers cultivate areas of 5-20 ha with triticale without declaring them. But at the same time in the counties of Arad, Caraș Severin, Sălaj and Satu Mare the surfaces have increased and will increase further.

Conclusions

(1). Triticale is a challenge for Romanian farmers.

(2). Also for them, it is necessary to establish the proper zones for triticale to avoid the competition with traditional cereals.

(3). Better information of the farmers, revealing the qualities but also the disadvantages of the triticale varieties.

(4). The future cultivation evolution of triticales depends on the value of the cultivars, especially on the quality of the grain, the high mass (lb/Abu).

(5). It depends on the animal husbandry policy.

(6). For the interest of nutritionists is necessary to point out its human dietary value.

(7). To increase the production parameters required the improvement of plant homeostasis, reducing the sterility of last flowers from the spikelet and terminal flowers from the ear, and plump grains (high TGW).

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