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A BRIEF REVIEW OF TRITICALE (X *TRITICOSECALE* WITTMACK) IN THE WORLD AND IN BULGARIA (OVERVIEW)

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Abstract. *Over the last 20 years, triticale areas in the world have been growing. On average, over 20 years, the area with triticale in the world is 3.4 million hectares. Most (83%) of triticale areas in the world are registered in Europe. The world leader in production areas with triticale is Poland. Second is Belarus, and third is Germany. Most of the arable land occupies triticale in Poland (12,988%), followed by Belarus (8,789%) and Luxembourg (7,434%). The beginning of the second decade of the 21st century marks a steady growth of the triticale areas in Bulgaria. The absolute maximum of the triticale areas in Bulgaria is registered in 2014 - 18907 ha. An average of 25 years triticale occupies 0.263% of the country's arable land area. The average yield of triticale grain in the world is 3,635 t/ha, with Europe's grain yield of triticale being higher by an average of 8% compared to the world average. The highest average yields in recent years are recorded in Chile (6,066 t/ha) and Germany (6,052 t/ha). The lowest average annual yields of triticale are over 1 t/ha obtained in Portugal, Kyrgyzstan, China, Tunisia and Australia. The average yields of triticale grain in Bulgaria are variable, especially during the first years since official statistics on culture. Since the beginning of the 21st century the average annual yields stabilized between 2,453 t/ha and 3,193 t/ha. The grain yield is positive, indicating that there is a proven increase in average yields for triticale grain.*

Keywords*: triticale, review, area, yields*

INTRODUCTION

According to a UN report, in 2050 the world population will reach 9.8 billion people, and in 2100 – 11.2 billion (UN, 2015). This requires a constant search for sustainable sources of food. It has long been clear that cereals are an indispensable source of nutrients and energy, and they were mainly relied on in the past, are still relied on in the present, and will be relied on in the future. It is no coincidence that the only agronomist to win the Nobel Peace Prize – Norman Borlaug – received it in 1970 precisely for his great achievements in wheat breeding, thanks to which, in less than 5 years, world grain production increased several times.

Genetic triticale (x *Triticosecale* Wittmack) is a wheat-rye amphidiploid, created by interspecific and intergeneric hybridization obtained by crossing the genomes of two different species - wheat and rye. The first hybrids are fertile progeny arising in the process of intergenetic hybridization and subsequent doubling of the chromosome set between the female parent of the genus *Triticum* and the male of the genus *Secale*. In 1969, the Canadian breeding program released the first triticale variety Rosner, which was a spring variety and showed good potential as a feedstock, distillery and food industry. The same year, the Spanish variety Cachirulo was released, but its application was limited by its tendency to lodging and poor baking qualities (ROYO, 1992). A real turning point in the development of triticale from a crop for genetic research into a crop with production significance occurred after 1983. At the 15th World Wheat Trial, the Polish triticale Lasko, breeded by Tadeusz Wolski, showed the highest productive potential and took first place in grain yield per hectare, leaving far behind the most productive varieties of soft winter wheat from more than 26 countries (TSVETKOV, 1989, STANKOV, 1993).

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In Bulgaria, in 1965, at the Agricultural University - Plovdiv, the first primary octaploid triticale AD-SOS-3 was obtained (KOLEV, 1967; KOLEV 1978). Intensive breeding and improvement activities followed, with the creation of the varieties Vihren and Persenk in 1984 and 1987, respectively, being a significant success (TSVETKOV, 1989). In the 1990s, triticale cultivation entered a new stage, associated with the development of animal husbandry and special bread production, mainly after the varieties Rakita, Zaryad and Meksitol1 created during this period (PANAYOTOV et al., 2000; TSVETKOV, 2002).

A new stage in the breeding of triticale in Bulgaria began with the creation of the latest varieties at the Dobruja Agricultural Institute - Gen. Toshevo. The varieties Colorit, Attila, Accord, Boomerang, Respect, Doni52, Irnik, Dobrujanets, Lovchanets , Blagovest and Borislav arouse interest among grain producers and are grown successfully mainly in Northern Bulgaria (BAYCHEV, 2004, 2005, 2006, 2009, 2012, 2013; BAYCHEV and PETROVA, 2011; VASILEVA et al., 2005). There is also interest in triticale from cereal producers in the rest of the country, with the Musala variety selected at the Sadovo Seed House and the Rozhen and Sadovets varieties created at the Sadovo Agricultural Research and Development Institute (STANKOV et al., 2014) being successfully grown.

RESULTS AND DISCUSSIONS

Distribution (areas) of triticale.

Over the past 20 years, the area under triticale in the world has been increasing (Fig. 1). From the mid-1990s to the beginning of the 21st century, triticale occupied from 2 million to nearly 2.5 million hectares. After the beginning of the century, a sharp increase in areas followed, reaching over 3.8 million hectares in 2005. This was followed by a slight decline in 2006 and a new increase, to reach the absolute maximum of the area under triticale in the world in 2009 – over 4.3 million hectares. On average, the area under triticale in the world for 20 years is 3.4 million hectares.

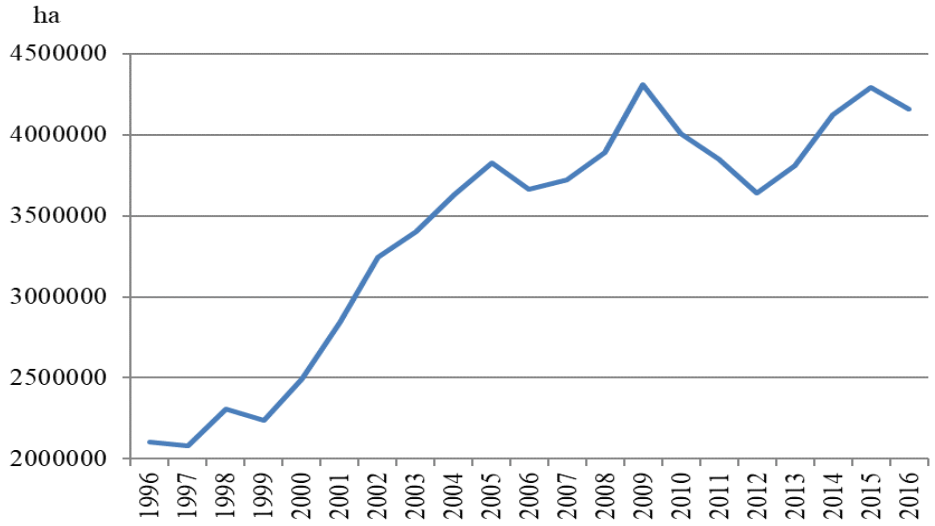

Figure 1. Triticale area in the world, ha (FAOSTAT | © FAO Statistics Division)

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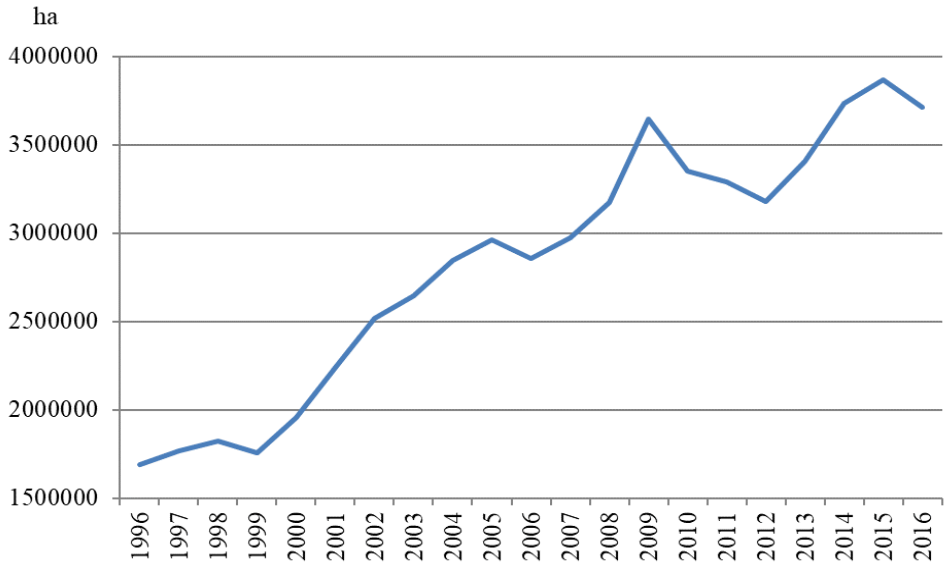

Figure 2. Triticale areas in Europe, ha (FAOSTAT | © FAO Statistics Division)

Since, on average over 20 years, nearly 83% of the world's triticale areas are registered in Europe, they follow similar trends described above for the state of triticale areas in the world (Fig. 2). By the beginning of the 21st century, the area under triticale in Europe was between 1.6 and 1.8 million hectares. At the beginning of the new century, in nine years, they increased sharply from 2 million hectares in 2000 to 3.6 million hectares in 2009. In 2015, a maximum of 3.9 million hectares under triticale was recorded in Europe. The average area under triticale in Europe over 20 years is 2.8 million hectares.

Although there is no data for some large grain-producing countries such as the USA, Ukraine, Argentina, etc., Figure 3 presents the top 10 countries in the world growing triticale on the largest areas. According to FAO data (http://faostat.fao.org/), the sole leader in the world in triticale production areas is Poland, with over 1.4 million hectares. Belarus is in second place with almost 500 thousand hectares. Germany follows with 396 and France with 334 thousand hectares. China is in fifth position with 239 thousand hectares, Russia is in sixth with 223 thousand hectares, Spain is seventh – 203 thousand hectares, Hungary is eighth (139 thousand hectares), Lithuania is ninth (100 thousand hectares) and the last of the top ten is Romania with 83 thousand hectares. The remaining countries growing triticale outside the top ten are presented in Figure 4. Here, Australia is first with 78 thousand hectares.

Countries with over 30,000 hectares of triticale are Austria (55,000 hectares), Czech Republic (40,000 hectares), Turkey (38,000 hectares) and Sweden (30,000 hectares). Over 20,000 hectares of triticale are grown in Chile (24,000 hectares), Serbia (23,000 hectares), Greece (22,000 hectares), Portugal (21,000 hectares) and Croatia (20,000 hectares). Countries with over 10,000 hectares of triticale are Tunisia (18,000 hectares), Brazil, Canada, Italy (17,000 hectares), Bulgaria, Bosnia and Herzegovina (16,000 hectares), Mexico (12,000 hectares), Latvia and the United Kingdom (11,000 hectares). The smallest areas of triticale (under 10 thousand hectares) are grown in Switzerland and Slovakia (9 thousand hectares),

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Belgium and Estonia (6 thousand hectares), Slovenia and Luxembourg (5 thousand hectares), the Netherlands (1,000 hectares) and Norway – 0.4 thousand hectares.

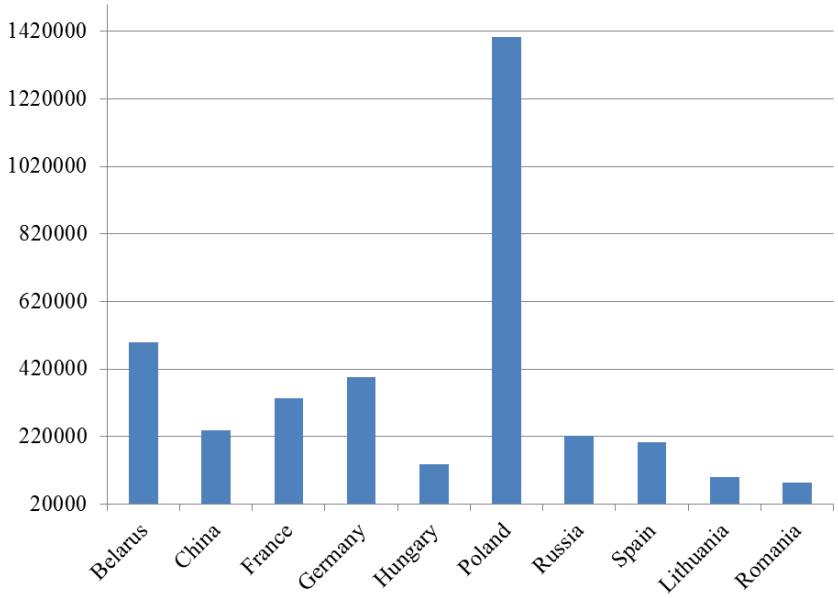

Figure 3. Top 10 countries with the largest areas of triticale, ha (FAOSTAT | © FAO Statistics Division)

In addition to the total area under triticale, an important factor is what proportion of the total arable land is occupied by triticale (Fig. 5). The largest proportion of arable land is occupied by triticale in Poland (12.988 %), followed by Belarus (8.789 %). and Luxembourg (7.434%).

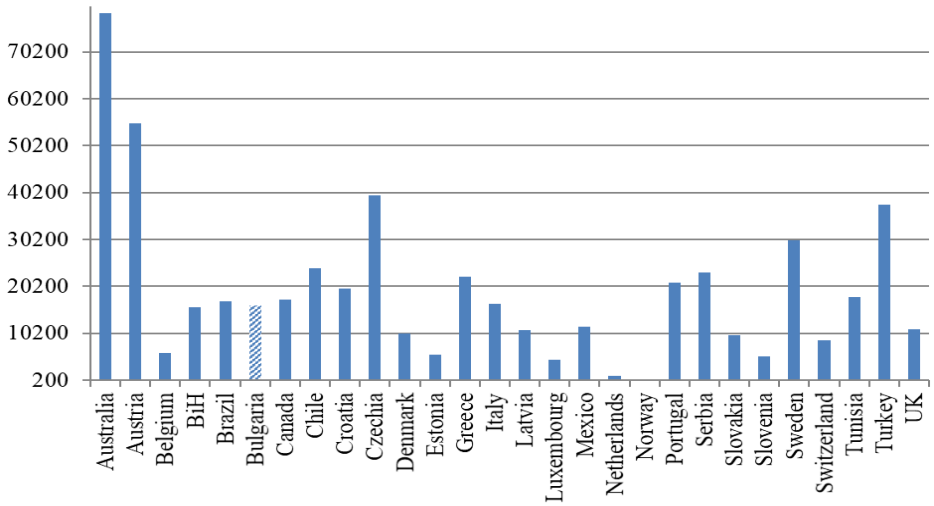

Figure 4. Areas in other triticale-producing countries, ha (FAOSTAT | © FAO Statistics Division)

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Countries where triticale is grown on more than 3% of the arable area are Lithuania (4.638%), Austria (4.114%), Hungary (3.219%) and Germany (3.367%). Over 1% of the arable area with triticale is harvested in Slovenia (2.874%), Croatia (2.264%), Switzerland (2.186%), Portugal (1.871%), France (1.821%), Spain (1.646%), Czech Republic (1.588%), Bosnia and Herzegovina (1.529%) and Greece (1.041%). In the remaining producing countries, triticale occupies less than 1% - Romania (0.962%), Serbia (0.893%), Latvia (0.846%), Estonia (0.816%) Slovakia (0.721%), Belgium (0.706%), Tunisia (0.617%), Bulgaria (0.460%) and Denmark (0.425%).

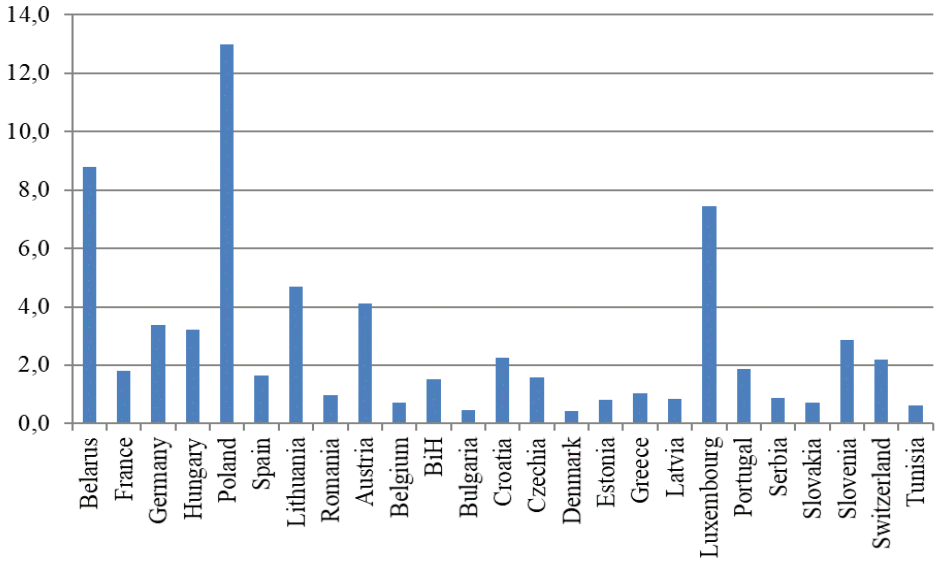

Figure 5. Triticale areas compared to cultivated area, %

In Bulgaria, official statistics on triticale production (areas, yields) have existed since 1992 (Fig. 6). In the first years (1992-1995), the areas with triticale were between 10-11 thousand hectares. After the mid-1990s, there was a decline in the areas to 4.2 thousand hectares, which is the absolute minimum of triticale grown in Bulgaria since statistics for this crop have existed. In 2002-2003, triticale returned to its positions from the beginning of the 1990s – 10-11 thousand hectares, and in the period 2007-2009, there was a new decline to 4.5-6.5 thousand hectares. The beginning of the second decade of the 21st century marked a permanent increase in the areas with triticale in our country. In 2010, the areas increased to 9800 ha, in 2013 they were 13700 ha, in 2017 – 18660 ha. The absolute maximum of the triticale harvested areas in Bulgaria was registered in the harvest year 2014 – 18907 ha.

In Bulgaria, over the past 25 years, arable land (excluding meadows, pastures and permanent crops) has varied between 3.085 million hectares in 2007 and 4.298 million hectares in 1997 http://www.fao.org/faostat/en/#country/27 . On average for the period 1992-2016, triticale occupies 0.263% of the country's arable area. The largest share of field areas was sown with triticale in the harvest year 2014 - 0.542%, and the smallest - in 1999 - 0.117%. In the last statistical year (2016), the share of triticale was 0.460% compared to all other field crops in Bulgaria.

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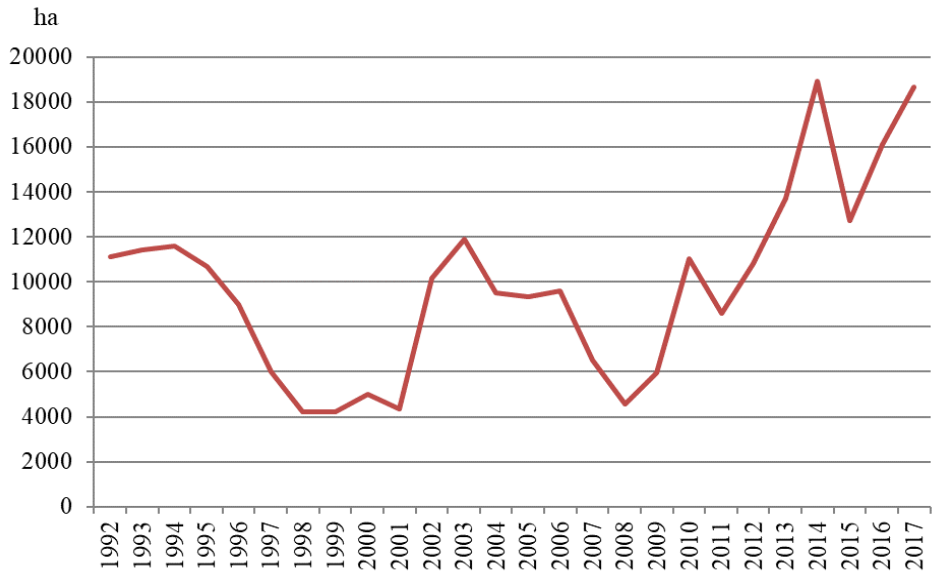

Figure 6. Triticale areas in Bulgaria , ha (FAOSTAT | © FAO Statistics Division)

Productivity (grain yield) of triticale.

Average triticale grain yields in the world over the last 20 years have varied from 3,093 t/ha in the 2003 harvest year to 4,111 t/ha in 2014, with the average triticale grain yield in the world for the period being 3,635 t/ha average 8% higher than the world average (Fig. 8).

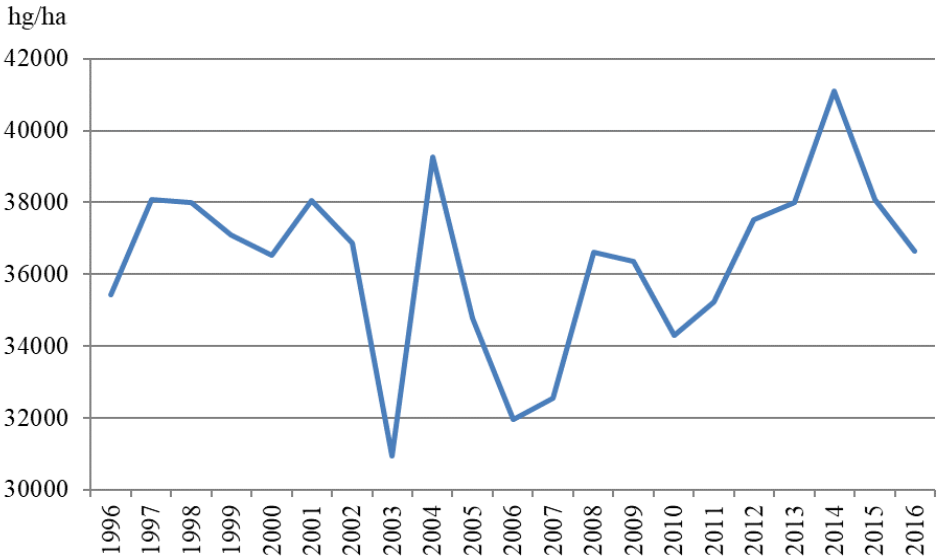

Figure 7. Triticale yields in the world, hg/ha (FAOSTAT | © FAO Statistics Division)

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The average triticale grain yields in Europe over the past 20 years have varied from 3,424 t/ha in the 2003 harvest year to 4,375 t/ha in the following 2004 year, with the average triticale grain yield in the world for the period being 3,949 t/ha .

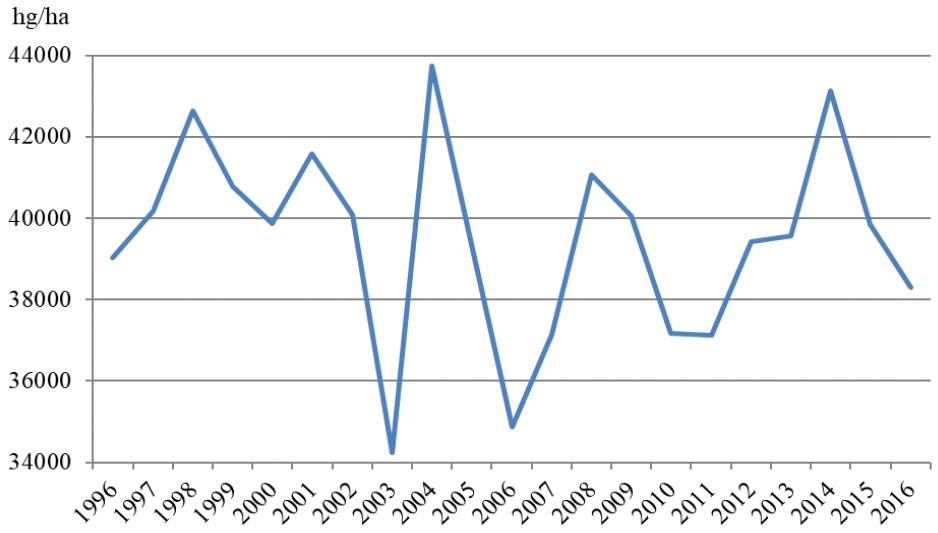

Figure 8. Triticale yields in Europe, hg/ha (FAOSTAT | © FAO Statistics Division)

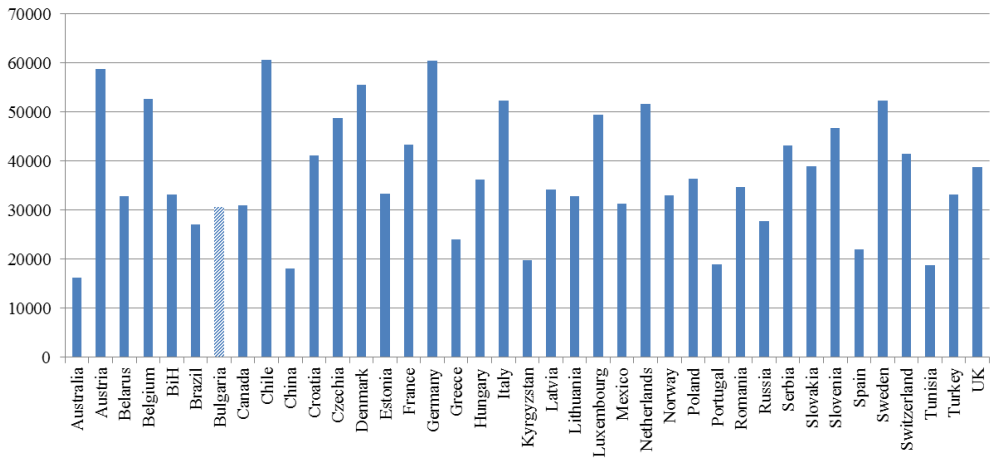

Figure 9. Yields in triticale producing countries, hg/ha (FAOSTAT | © FAO Statistics Division)

Average triticale grain yields vary by region, with the average maximum yield rarely exceeding 6 t/ha (Fig. 9). The highest average yields for the country in recent years have been in Chile (6,066 t/ha) and Germany (6,052 t/ha).

Countries where the average grain yield for the country exceeds 5 t/ha are Austria (5.9 t/ha), Denmark (5.6 t/ha), Belgium (5.3 t/ha), Italy, the Netherlands and Sweden (5.2 t/ha) and Luxembourg - 5 t/ha .

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Over 4 t/ha average grain yield was obtained in the Czech Republic (4.9 t/ha), Slovenia (4.7 t/ha), France and Serbia (4.3 t/ha) and Switzerland and Croatia – 4.1 t/ha .

The countries with average grain yields of over 3 t/ha are the most numerous. The United Kingdom and Slovakia – 3.9 t/ha , Poland and Hungary – 3.6 t/ha , Romania – 3.5 t/ha , Latvia – 3.4 t/ha , Turkey, Norway, Lithuania, Estonia, Bosnia and Herzegovina and Belarus – 3.3 t /ha, Bulgaria and Mexico – 3.1 t/ha and Canada - 3 t/ha .

Over 2 t/ha average triticale grain yield was obtained in Brazil and Russia – 2.7 t/ha , Greece (2.4 t/ha) and Spain (2.2 t /ha).

The lowest average annual yields of triticale are over 1 t/ha , obtained in Portugal and Kyrgyzstan (1.9 t/ha), China and Tunisia (1.8 t/ha) and Australia – 1.6 t/ha .

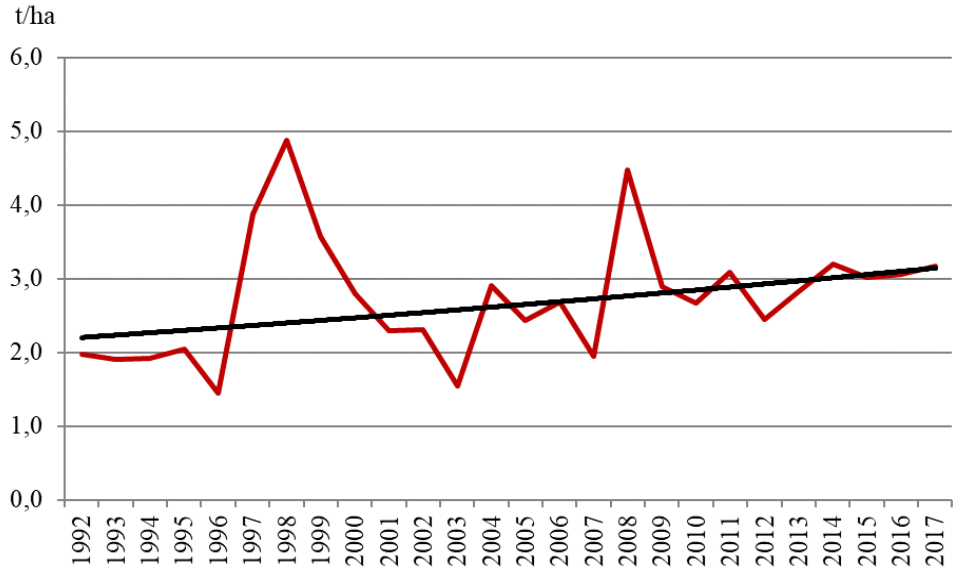

Figure 10. Triticale grain yields in Bulgaria , t/ha (FAOSTAT | © FAO Statistics Division)

Average grain yields in Bulgaria are fluctuating, especially in the first years since official statistics on the crop have been available. The absolute minimum was recorded in 1996 – 1,444 t/ ha , and the maximum only two years later in 1998 – 4,881 t/ ha . After the beginning of the 21st century , the average annual yields stabilized at levels varying between 2,453 t/ ha in 2012 and 3,193 t/ ha in the harvest year 2014. The trend in grain yield is positive, which indicates that there is a statistically dependent increase in the average grain yields of triticale for the country.

CONCLUSIONS

Over the past 20 years, the area under triticale in the world has been increasing, with the absolute maximum in 2009 – over 4.3 million hectares. The average area under triticale in the world for 20 years is 3.4 million hectares, with 83% of them registered in Europe. The sole leader in triticale production areas is Poland, with over 1.4 million hectares. In second place is Belarus with almost 500, and in third place is Germany with 396 thousand hectares. The largest

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part of the arable land is occupied by triticale in Poland (12.988 %), followed by Belarus (8.789 %). and Luxembourg (7.434%).

The beginning of the second decade of the 21st century marked a permanent increase in the areas with triticale in our country. The absolute maximum of the areas harvested with triticale in Bulgaria was registered in the harvest year 2014 – 18907 ha. On average for 25 years, triticale occupies 0.263% of the arable area of the country.

The average yield of triticale grain in the world is 3,635 t/ha, with the European triticale grain yield being on average 8% higher than the world average. The highest average yields in recent years have been recorded in Chile (6,066 t/ ha) and Germany (6,052 t/ ha). The lowest average annual yields of triticale are over 1 t/ ha, obtained in Portugal, Kyrgyzstan, China, Tunisia and Australia.

Average grain yields in Bulgaria are fluctuating, especially in the first years since official statistics on the crop have been available. After the beginning of the 21st century, average annual yields have stabilized between 2,453 t/ ha and 3,193 t/ha. The grain yield trend is positive, which indicates that there is a proven increase in the average grain yields of triticale for the country.

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