APPROACH FOR ORGANIC TRITICALE (X *TRITICOSECALE* WITTM.) FARMING I. GENOTYPIC SPECIFIC IN THE ACCUMULATION OF BIOMASS.

H. KIRCHEV[1], Angelina MUHOVA[2], Rumyana GEORGIEVA[1]

[1]Department of Crop Science, Faculty of Agronomy, Agricultural University, 12 Mendeleev str., 4000 Plovdiv, Bulgaria
[2]Research Institute of Field Crops of the Agricultural Academy, 2 G. Dimitrov str., 6200 Chirpan, Bulgaria
hristofor_kirchev@abv.bg

***Abstract**: A field experiment was set in the period 2014-2017 on the experimental field of the Research Institute of Field Crops of the Agricultural Academy, Chirpan. Three triticale varieties were used – the standard Colorit, and other two varieties created at Dobrudja Agricultural Institute – Gen. Toshevo, Bulgaria: Boomerang and Respect. The experiment consisted of a randomized complete block design after two predecessors – sunflower and durum wheat with four replication and plots of 10 m^2 planted at a sowing rate of 550 viable seeds m^{-2}. To achieve the aim of the study, during the vegetation of the triticale, fresh plants were taken by stages as follows: Tillering – leaves; Spike emergence – leaves, stems, spikes; Maturity – straw (leaves+stems), spikes, grains, glumes. After the two predecessors in the phase of spike emergence, the stems are the largest share of the plant, followed by the leaves and the spikes. However, the stems have a larger share after sunflower, and the share of leaves and spikes is close to the two predecessors. Although the relative share of the spikes is close after the two precursors, in the maturity phase, the relative share of the grain after durum wheat is 6.3% less than after sunflower, and the share of the glumes is 17.4% more.*

Key words: *triticale, organic, biomass.*

INTRODUCTION

Genetically triticale (× *Triticosecale* Wittmack) is an amphiploid produced by crossing the genomes of two different species - wheat and rye. The first hybrids were fertile progenies, which arose from an inter-generic hybridization and followed by chromosome doubling between a female parent from the genus *Triticum* and the male parent from the genus *Secale*. The majority of the today's varieties are descendants of a primary hybrids, which involve either common (*Triticum aestivum* L., 2n=42=AABBDD) or durum (*Triticum durum* Desf., 2n=28=AABB) wheat as a female parent and cultivated diploid rye (*Secale cereale* L., 2n=14=RR) as a male parent (MADIC ET AL., 2013; MADIC ET AL., 2015; LOSERT ET AL., 2017; ITTU ET AL., 2014; XUE-FENG ET AL., 2004).

A successful man-made cereal species triticale is very suitable for growing in organic crop management systems but little research has been conducted on breeding triticale for organic agriculture (KRONBERGA ET AL., 2013; KLIMA ET AL., 2015; GIBCZYN´SKA ET AL., 2016; HEIN & WASCHL, 2015; VOICA, 2014; KUROWSKI ET AL., 2013; SOLARSKA ET AL., 2010; KRONBERGA, 2008).

MATERIAL AND METHODS

A field experiment was set in the period 2014-2017 on the experimental field of the Research Institute of Field Crops of the Agricultural Academy, Chirpan. Three triticale varieties were used – the standard Colorit, and other two varieties created at Dobrudja Agricultural Institute – Gen. Toshevo, Bulgaria: Boomerang and Respect.

The experiment consisted of a randomized complete block design after two predecessors – sunflower and durum wheat with four replication and plots of 10 m^2 planted at a sowing rate of 550 viable seeds m^{-2}.

To achieve the aim of the study, during the vegetation of the triticale, fresh plants were taken by stages as follows: Tillering – leaves; Spike emergence – leaves, stems, spikes; Maturity – straw (leaves+stems), spikes, grains, glumes.

The plants are taken from 1/4 meter, divided into organs, dried to an absolutely dry mass and weighed.

In order to establish statistically significant differences between variants, a dispersion analysis (ANOVA) was applied.

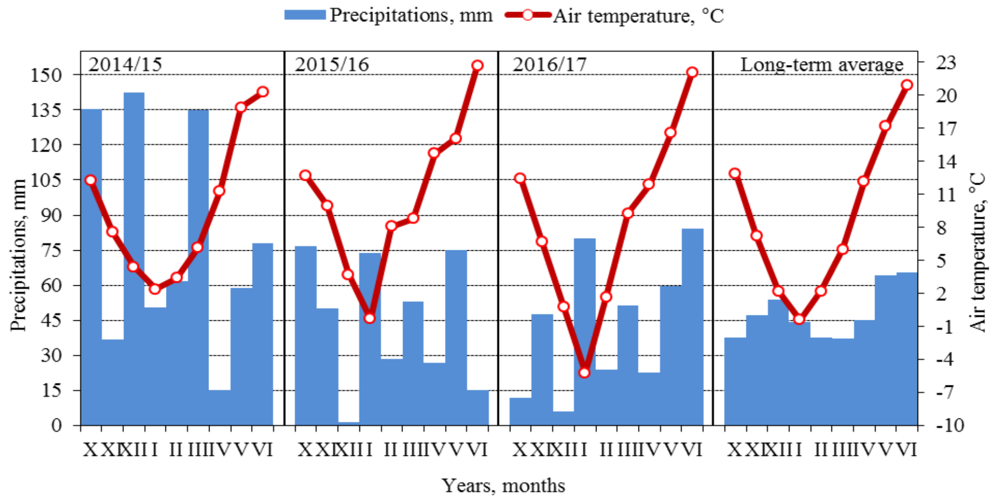

Figure. 1. Temperature and precipitation during triticale vegetation.

The experimental station of the Research Institute of Field Crops - Chirpan has a field with a powerful humus horizon (80-115 cm) with a thrush - grained, passing to a slightly pronounced prismatic structure at its lower part. The high moisture content of the Pelic Vertisols is determined by their heavy loamy mechanical composition. They swell strongly when moistened and reduce their volume when they dry out. Because of their high moisture, these soils are suitable for growing triticale, especially in years of lasting droughts.

Meteorological conditions are different during the three years of the study. Figure 1 shows the three-year differences over the long-term average.

RESULTS AND DISCUSSION

At the beginning of tillering there are differences in the accumulation of dry biomass by years and by predecessors, as compared to the differences between the different varieties. This makes it necessary for the difference in the values of the varieties studied to be examined by predecessors.

1. Colorit after sunflower accrues to this phase between 92.5 and 151.8 kg/da or an average of 123.0 kg/da, and after durum wheat between 90.7 and 176.0 kg/da or an average of 132.1 kg/da.

2. After sunflower, the Boomerang variety accumulates between 112.1 and 147.7 kg/da or 135.1 kg/da on average, and after durum wheat between 69.8 and 160.3 kg/da or an average of 120.7 kg/da.
3. Respect variety, after sunflower accumulates to this phase between 109.8 and 139.4 kg/da or an average of 125.6 kg/da, and after durum wheat between 48.4 and 148.5 kg/da or an average of 100.2 kg/da.

As the accumulated dry biomass, on average, of the varieties and the period is higher after the predecessor sunflower (127.9 kg/da) than after the durum wheat (117.7 kg/da), it can be assumed that the triticale varieties as cereal crops exhibit a similar a reaction at the beginning of tillering relative to the two predecessors.

The Boomerang variety has the highest amount of dry biomass - 135.1 and 120.7 kg/da, or 127.9 kg/da compared to the other two (Colorit - 127.5 kg/da, Respect - 112.9 kg/da) after the two predecessors.

Figure 2. Dry biomass accumulation (C-Colorit; B-Boomerang; R-Respect).

On average, for the three years of the study and after the two predecessors, the varieties are ranked in the following descending order of the size of the organic yield:

After sunflower - Boomerang> Respect> Colorit.

After durum wheat - Colorit> Boomerang> Respect.

The spike emergence phase is characterized by intense linear growth of vegetative organs, which significantly increases the organic yield by variety, the increase being between 2 and almost 3 times after different ancestors over the years as follows:

1. Colorit variety, after sunflower accumulates between 281.4 and 366.9 kg/da or an average of 333.4 kg/da, and after durum wheat between 240.8 and 342.3 kg/da or an average of 294.6 kg/da.
2. Boomerang variety, after sunflower between 304.5 and 366.7 kg/da or an average of 341.9 kg/da, and after durum wheat between 196.0 and 347.4 kg/da or an average of 290.3 kg/da.
3. Respect variety, after sunflower between 254.8 and 334.7 kg/da or an average of 298.5 kg/da, and after durum wheat between 264.6 and 384.3 kg/da or an average of 339.9 kg/da.

On the average, after the two predecessors, the highest amount of dry biomass was 319.2 kg/da by Respect compared to the other two (Colorit - 314.0 kg/da, Boomerang -316.1 kg/da.

The average organic yield of the varieties after sunflower is 324.6 kg/da, and after durum wheat 308.3 kg/da.

In the analysis of the varieties with regard to the predecessors, there are no differences in the organ distribution compared to the total biological yield. After the two predecessors, the stems occupy the largest share, followed by the leaves and spikes (Table 1). However, the stems have a larger share after sunflower, and the share of leaves and spikes is close to the two predecessors.

Table 1.

Biomass yield in spike emergence and relative share of organs (on average for 3 years), kg/da.

Variety	Biomass yield				Proportion of the total yield		
	leaves	stems	spikes	total	leaves	stems	spikes
after sunflower							
Colorit	62.7	222.6	48.2	333.5	0.188	0.667	0.145
Boomerang	69.2*	216.3	56.4*	341.9	0.202*	0.663	0.165*
Respect	57.3*	195.8*	45.4	298.5*	0.192	0.656	0.152
after durum wheat							
Colorit	62.6	185.4*	46.6	294.6	0.213	0.629*	0.158
Boomerang	54.0*	183.7*	52.6*	290.3*	0.186*	0.633	0.182*
Respect	69.8*	214.6	55.5*	339.9*	0.206*	0.631*	0.163*

** - Significance at P= 5%*

The studied triticale varieties in the full maturity phase formed the following biological yield after the two predecessors over the years:

1. Colorit after sunflower between 508.3 and 565.1 kg/da or an average of 541.0 kg/da, and after durum wheat between 523.0 and 612.4 kg/da or an average of 571.6 kg/da.
2. Boomerang after sunflower between 513.4 and 588.8 kg/da or an average of 556.5 kg/da, and after durum wheat between 452.3 and 482.2 kg/da or an average of 468.9 kg/da
3. Respect after sunflower between 417.3 and 745.2 kg/da or an average of 534.0 kg/da, and after durum wheat between 484.3 and 639.4 kg/da or an average of 549.4 kg/da.

On average, after two precursors, the Colorit variety accumulates the largest amount of dry biomass - 556.4 kg / da compared to the other two (Boomerang - 512.7 kg / da, Respect - 541.7 kg / da).

The biological yield of triticale to the maturity phase during the period 2015-2017 is mainly formed by the spikes which, after sunflower, account for about 0.356 kg/da in total biological yield, and after durum wheat on average about 0.353 kg/da (Table 2).

In analyzing the varieties with respect to the predecessors, no differences are found regarding the distribution of the organs in relation to the total biological yield. After the two predecessors, the spikes are the largest share, followed by the straw, the grain and the weeds. Although the relative share of the spikes is close to both predecessors, the relative share of grain after durum wheat is 6.3% less than after sunflower, and the share of glumes is 17.4% more.

Table 2.

Biomass yield in maturity and relative share of organs (on average for 3 years), kg/da.

Variety	Biomass yield					Proportion of the total yield			
	straw	spikes	grains	glumes	total	straw	spikes	grains	glumes
after sunflower									
Colorit	152.5	194.3	142.2	52.1	541.1	0.282	0.360	0.243	0.096
Boomerang	160.8*	197.9	134.0	63.9*	556.5*	0.289	0.356	0.241	0.115*
Respect	159.5*	187.3*	124.9*	62.0*	534.0	0.299*	0.351	0.234	0.116*
after durum wheat									
Colorit	183.2*	194.2	116.0*	78.2*	571.6*	0.320*	0.340*	0.203*	0.137*
Boomerang	127.2*	170.9*	117.6*	53.3	468.9*	0.271	0.365	0.251	0.114
Respect	161.9	193.7	119.9*	73.8*	549.3	0.294	0.353	0.218*	0.134*

** - Significance at P= 5%*

CONCLUSIONS

After the two predecessors in the phase of spike emergence, the stems are the largest share of the plant, followed by the leaves and the spikes. However, the stems have a larger share after sunflower, and the share of leaves and spikes is close to the two predecessors.

Although the relative share of the spikes is close after the two precursors, in the maturity phase, the relative share of the grain after durum wheat is 6.3% less than after sunflower, and the share of the glumes is 17.4% more.

BIBLIOGRAPHY

KRONBERGA, A., LEGZDIŅA, L., STRAZDIŅA, V., & VICUPE, Z. (2013). Comparison of selection results in organic and conventional environments for winter triticale. Proceedings Of The Latvian Academy Of Sciences. Section B: Natural, Exact & Applied Sciences, 67(3), 268-271

GIBCZYN´SKA, M., DAWIDOWSKI, A., SOBOLEWSKA, M., JAROSZEWSKA, A., & LEWANDOWSKA, L. (2016). Analysis of influence farming systems on chemical composition of four variety of triticale winter (x *Triticosecale* Wittm. Ex A. Camus) grain. Folia Pomeranae Universitatis Technologiae Stetinensis, Agricultura, Alimentaria, Piscaria Et Zootechnica, 326(38/2), 37-46.

KLIMA, K., ABZA, T., & LEPIARCZYK, A. (2015). Yielding of spring triticale grown under organic and integrated systems of farming and economic indicators of its production. Journal Of Research And Applications In Agricultural Engineering, 60(3), 142-145.

MADIC, M., UROVIC, D., PAUNOVIC, A., JELIC, M., KNEZEVIC, D., GOVEDARICA, B. (2015). Effect of nitrogen fertilizer on grain weight per spike in triticale under conditions of central

Serbia. 6th International Scientific Agricultural Symposium "Agrosym 2015", Jahorina, Bosnia And Herzegovina, October 15-18, 2015. Book Of Proceedings, 483-487.

MADIC, M., UROVIC, D., MARKOVIC, G., PAUNOVIC, A., JELIC, M., KNEZEVIC, D. (2013). Grain yield and yield components of triticale on an acid soil depending on mineral fertilisation and liming. 4th International Scientific Symposium "Agrosym 2013", Jahorina, Bosnia And Herzegovina, 3-6 October, 2013. Book Of Proceedings, 232-237.

HEIN, W., & WASCHL, H. (2015). Grain yield and crude protein content of triticale varieties from organically cultivated sites in the humid climatic region in the years 2010-2014. Future Seed - Production, Marketing, Use And Conservation. 24-26 November, 2014 Raumberg-Gumpenstein, Austria, 49-50.

VOICA, M. (2014). Reactia unor soiuri de grâu si triticale cultivate în sistem ecologic la S.C.D.A. Pitesti. Analele Institutului National De Cercetare-Dezvoltare Agricola Fundulea, 8239-47.

KUROWSKI, T. P., DAMSZEL, M., WYSOCKA, U., SADOWSKI, T., & RYCHCIK, B. (2013). Health status of winter triticale under conversion from the conventional production to organic systems. Progress In Plant Protection, 53(1), 207-210.

SOLARSKA, E., KUZDRALIN´SKI, A., WÓJCIK, W., & TARGON´SKI, Z. (2010). Mycotoxins in winter triticale cultivated in organic production system. Journal Of Research And Applications In Agricultural Engineering, 55(4), 102-107.

KRONBERGA, A. (2008). Formation of triticale crop ideotype for organic farming. Options Méditerranéennes. Série A, Séminaires Méditerranéens, (81), 391-393.

LOSERT, D., MAURER, H. P., MARULANDA, J. J., & WÜRSCHUM, T. (2017). Phenotypic and genotypic analyses of diversity and breeding progress in European triticale (× *Triticosecale* Wittmack). Plant Breeding, 136(1), 18-27.

ITTU, G., SAULESCU, N., ITTU, M., & MUSTATEA, P. (2014). Present and perspectives in Romanian triticale breeding program. Communications In Agricultural And Applied Biological Sciences, 79(4), 185-191.

XUE-FENG, M., PENG, F., & GUSTAFSON, J. P. (2004). Polyploidization-induced genome variation in triticale. Genome, 47(5), 839-848.