STUDIES REGARDING MORPHOLOGICAL, BIOCHEMICAL AND PRODUCTION ASPECTS FOR SOME TRITICALE TYPES (*TRITICOSECALE* WITTMACK) IN THE CLIMATE AND SOIL CONDITIONS OF ARAD

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Abstract. *The present study focuses on the behavior of the main autumn triticale types, recommended by domain experts, in the temperature, humidity and soil conditions found in the Arad area. The study is motivated by the need to find the best solutions to expand this crop, considering that this species represents an essential source of carbon hydrates and proteins. A mono-factorial experiment was performed with 6 types of autumn triticale, in optimal technological conditions, in 4 repetitions. The experimental variants are represented by the following triticale types: V1 – Tulnic; V2 – Haiduc; V3 – Stil; V4 – Negoiu; V5 – Mv Medal; V6 – Oda Fd. The average of the 6 studied types was taken as the witness variant. During our experiments, the average values for temperature, precipitations, nebulosity, and humidity, didn't register significant differences compared to the multiannual average. The temperatures during the cultivation period for triticale, from October to June, were only slightly higher than normal and didn't hold significant influence over the plant's growth and development. Precipitations were sufficient for most of the vegetation period, with a small deficit for the months March-April and an increase in May. The following aspects were evaluated for each experimental variant: plant size, number of spikelets per ear, number of grains per ear, Weight of 1000 grains, hectoliter weight, seeds and straws production, as well as protein, fat and starch content (given in percentage). In the end, the economic efficiency of each type was evaluated. The interaction between the genotype and the environment generates a high degree of variability in regards to the growth and development of cereal plants, especially of triticale species (Triticosecale Wittmack). According to the data obtained in this study, the area of Câmpia Crişurilor can be recommended for the successful cultivation of some autumn triticale types in optimal conditions and with great efficiency.*

Keywords: *Triticosecale Wittmack, Arad, triticale.*

INTRODUCTION

Cereals represent the most important category of plants, covering the biggest surface on Earth. There is a need for the continued growth of cereals production and improvement of harvest quality, considering that in the present, most countries produce under 200 kg/citizen/year, and the optimal need is considered to be around 500 to 700 kg/citizen/year (AXINTE et al., 2006; ION, 2010).

Consumed in various forms (grounded and prepared as bread, semolina, pasta or boiled and consumed as such) cereal grains, and triticale implicitly, represent the basic food for almost the entire world population, which makes this crop a top priority in agriculture, at both national and international level (BÂLTEANU et al., 1991; ROMAN et al., 2011).

Exploitation of surfaces less productive for cereals, grains especially, of fields affected by lack of or excess water, poor in nutritive elements, as well as those that are acid or salty, compel a special attention to this species (SINESCU, 2010).

The main triticale producers are countries such as Poland, Germany, Belarus, France, Russia, China, Spain, Hungary, Lithuania, and Australia, where crop surfaces reach approximately 3,5 mil. ha (ISTIS, 2018). In 2014, according to The Food and Agriculture Organization of The United Nations (FAO), were harvested 17,1 million tons from 37 countries (FAO, 2014).

The importance of triticale crops is given by the plant's characteristics, like the lack of sensibility to daylight length, the capacity to grow on soils poor in nutritive elements, the high protein content, low-temperature resistance, high productivity potential, feasibility of complex use in the human diet, increased drought resistance, and use as fodder for birds and animals (AXINTE et al., 2006; BÂLTEANU et al., 1991).

The bakery values for triticale are lower than for wheat. Bread of higher quality is obtained if 20-30% of triticale flour is mixed with 70-80% wheat flour (STARODUB, 2008).
From an agronomic perspective, the triticale crops offer the advantage of full mechanization.
Triticale is a great pre-emergent plant for most crops because it frees the field early, leaves it clear of weeds and allows plowing even in summer (ION, 2010; ROMAN et al., 2011).

Besides a series of enhanced characteristics, such as high nutritive value or being a base for bread, this hybrid between wheat and rye, is tolerant to aluminum ions toxicity and has increased resistance to a wide range of diseases and pests (LĂZĂREANU, 2017).

Following the achievements obtained in crop improvement, especially in the recent period, triticale is currently a crop in full expansion in Romania, covering a surface of approximately 150,000 ha.. Preferred areas of cultivation are plains: Romanian Plain, Dobrogea, Banat Plain, Transylvania Plain. Triticale can be cultivated in all hilly areas, in submontane regions and intramontane depressions from Transylvania, North-West of country and North of Moldavia (FAO, 2016).

MATERIALS AND METHODS

The following materials were used to perform the experiments:

- -alluvial soil with pH = 7,0 – 7,5; Humus = 3,6 – 3,93 %; Clay = 33-35 %; Groundwater depth = 60 – 70 cm; Mobile Phosphorus = 12,6 – 17,7 mg/100g soil; Total Nitrogen = 0,16 – 0,18 mg/100g soil;
- -plot surface 20 m^2, l = 10 m, w = 2 m, protection space with a width of 3 m, 2m space between repetitions, paths of 0,5 m between variants;
- -triticale seeds of Tulnic, Haiduc, Stil, Negoiu, Mv Medal, and Oda Fd types.

Soil work consisted in:

- -autumn plowing, at 20-22 cm depth, leveled and kept clean of weeds until sowing;
- -in the autumn, before plowing, the soil was harrowed and the germinative bed was prepared with a combine, at 4-5 cm depth;
- -sowing was performed in the autumn, in October, at 4-5 cm depth;
- -over the entire vegetation period, the paths were maintained clear of weeds through specific maintenance works.

Fertilization was done during the preparation of the germinative bed, with a complex NPK fertilizer: N = 70 kg/ha, P = 40 kg/ha and K = 50 kg/ha.

The mono-factorial experiment with 6 types of triticale was performed under normal technological conditions, in 4 repetitions (JITĂREANU, 1994; SĂDOIU, 2012).

The types of triticale used as experimental variants were V1 - Tulnic; V2 – Haiduc; V3 – Stil; V4 – Negoiu; V5 - Mv Medal; V6 –Oda Fd. The average value of the 6 triticale types taken into study served as a witness variant.

The behavior of the triticale and wheat species was analyzed by comparison of the average value of the 6 and 7 types, respectively, taken into the study at the Research Station (UNGUREANU et al., 2019).

RESULTS AND DISCUSSIONS

Climatic conditions between the years 2018-2019 in Arad

The relative temperature, precipitations, nebulosity and humidity conditions didn't register significant differences compared to the multiannual average values (Meteo Blue Arad Archives).

The temperatures registered during the cultivation period, the months October-June respectively, were a bit higher than usual but didn't hold significant influence over the plant's growth and development.

Precipitations were, overall, sufficient for the most vegetation period, with a little deficit during March-April, and an increase at the end of April and during May.

Analyzing the climatic conditions between 2018 and 2019, it can be affirmed that they were favorable for the cultivation of triticale in good conditions (Figures 1 and 2).

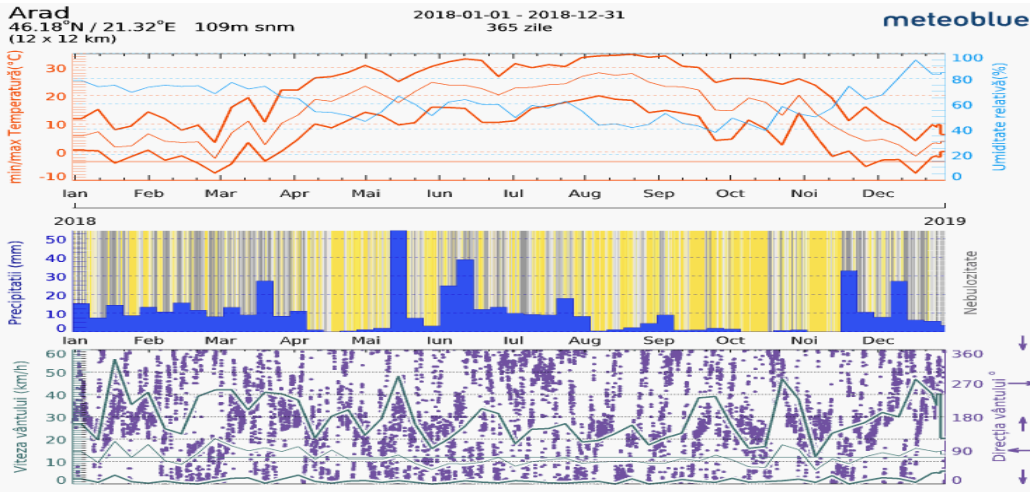

Figure 1. The average thermic and precipitation values for January – December 2018 in Arad (https://www.meteoblue.com- Meteorological Archive Arad).

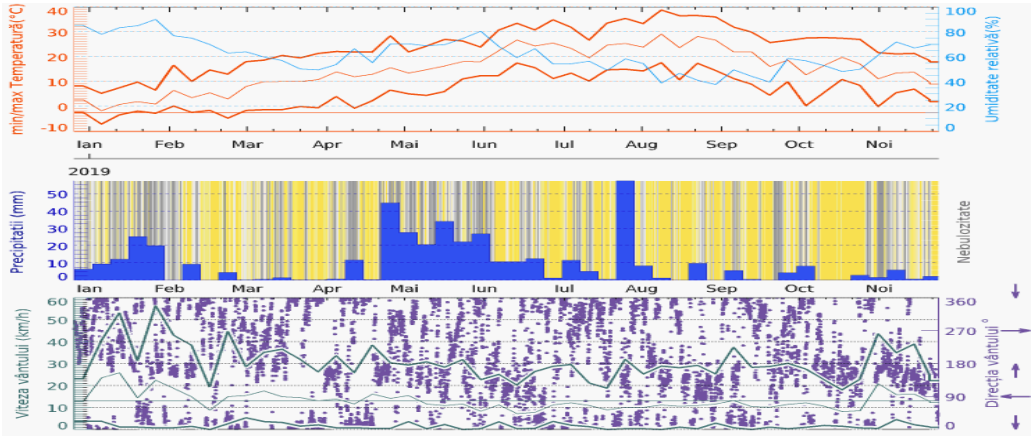

Figure 2. The average thermic and precipitation values for January – December 2019 in Arad (https://www.meteoblue.com- Meteorological Archive Arad).

Results

Applying the cultivation technology recommended by specialists for the triticale crop has highlighted the growth in normal conditions of the 6 types taken into study.

The plant's size represents the result of the interaction between the growth potential of the cultivated type and the influence of the environmental conditions, along with the genotype's capacity to take advantage of the applied phytotechnical factors.

For the triticale types studied, the plant's sizes were between 110 cm (Stil) and 117 cm (Haiduc), and 113,5 on average (Witness variant). Special attention was drawn by Negoiu type with 116 cm, and Tulnic type, for which the plants had an average height of 115 cm. MvMedal type plants had a height of 11 cm, being exceeded by the other types, except Stil, plants which had only 110 cm in size (Figure 3).

By comparing the size of triticale plants (113,5 cm) with that of the wheat plants (89 cm), in the same experimental conditions, it was found that triticale plants were higher than wheat plants by 24,5 cm, which makes triticale more advantageous than wheat if used as fodder, especially in the conditions of the Cattle Breeding Station (S.C.D.C.B Arad), where the experiments took place (Figure 4).

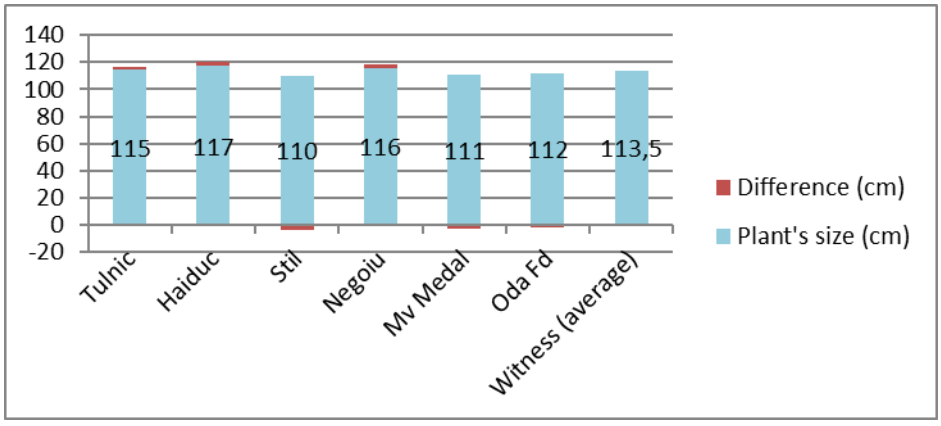

Figure 3. The influence of the pedo-climatic conditions over the plant's size for triticale

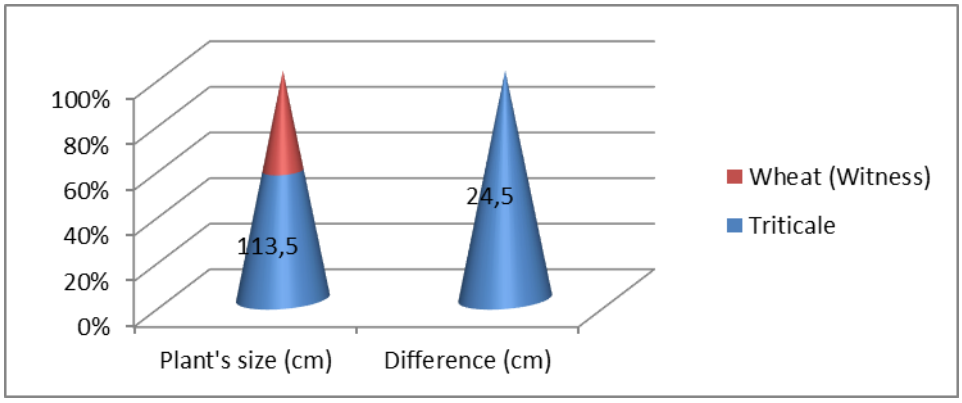

Figure 4. The influence of the pedo-climatic conditions over the plant's size for triticale and wheat

The triticale types studied had over 29 spikelets on every ear, with Tulnic and Negoiu types reaching a maximum average number of 33 spikelets per ear. The fewest spikelets were recorded for Stil and MvMedal types, with 29 spikelets per ear, followed by Oda Fd type with 30 spikelets per ear. Good results were obtained for Haiduc type, for which the number of spikelets/ear reached 32, being second place and exceeding the witness variant, which represents the average value of all types taken into the study, with a spikelet per ear (Figure 5).

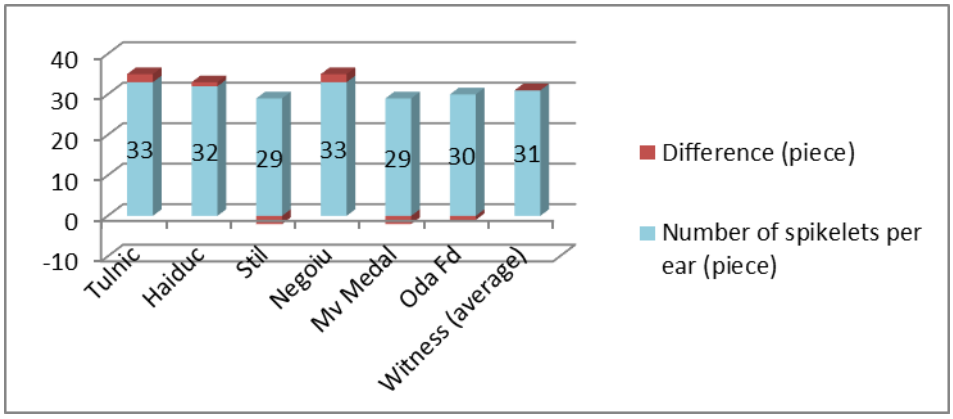

Figure 5. The influence of the pedo-climatic conditions on the number of spikelets per ear for triticale

By analyzing the behavior of the wheat types and triticale types in the conditions from S.C.D.C.B. Arad, it was found that the average number of spikelets is bigger for wheat plants (32 spikelets/ear) compared to the triticale plants (31 spikelets/ear). The 1 spikelet/ear difference is, however, insignificant (Figure 6).

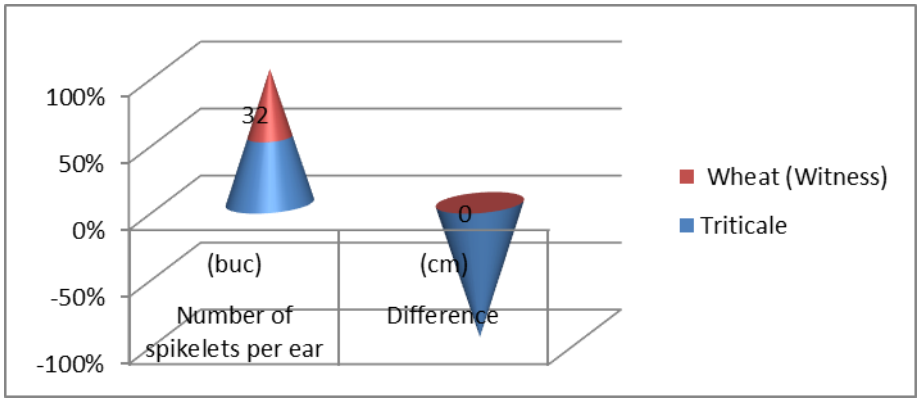

Figure 6. The influence of the pedo-climatic conditions over the number of spikelets per ear

The number of grains per ear for the studied triticale types was 34. The best results were obtained for Tulnic and Negoiu types, with 35 grains per ear, followed by Haiduc and Oda Fd which had 34 grains per ear. The smallest number of grains per ear was obtained for Stil and MvMedal types, which had 33 grains per ear (Figure 7).

By comparing the number of grains per ear of the two cereal species, autumn wheat and autumn triticale, it was found an equal number of seeds (34 kernels/ear) (Figure 8).

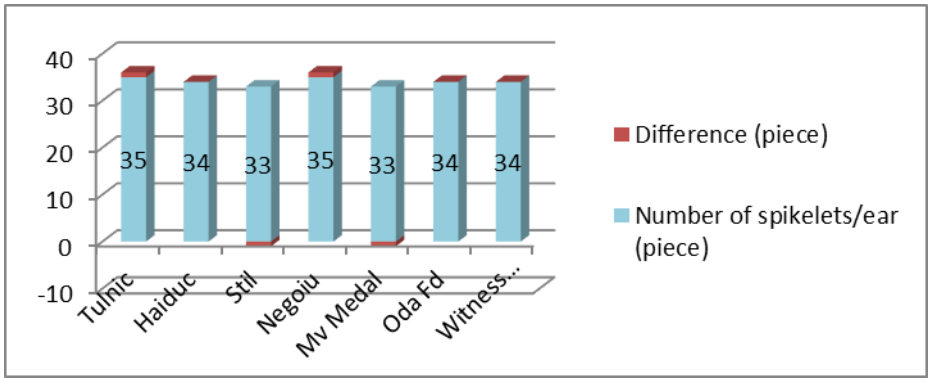

Figure 7. The influence of the pedo-climatic conditions over the number of grains per ear for triticale

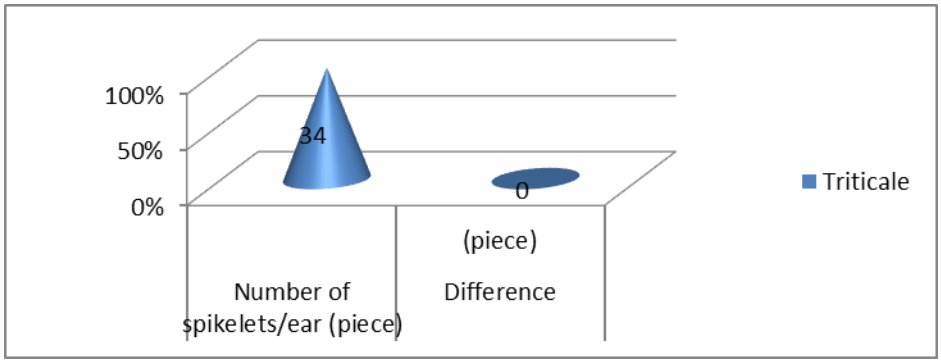

Figure 8. The influence of the pedo-climatic conditions over the number of grains per ear for triticale and wheat

The Weight of 1000 grains was influenced by the characteristics of the studied types but also by the pedo-climatic and technological conditions, fluctuating between 44 g for Oda Fd type and 48 g for Haiduc and Mv Medal types. For Stil type was recorded a weight of 1000 grains of 47 g, exceeding that of the witness by 1 g. For Negoiu type, the weight of 1000 grains was equal to the witness, and for the Tulnic type, the value was 45 g (Figure 9).

The research done on the kernels of the two cereal species has shown that the grains obtained from triticale plants (MMB = 46 g) were heavier than those obtained from wheat plants (MMB = 43 g) (Figure 10).

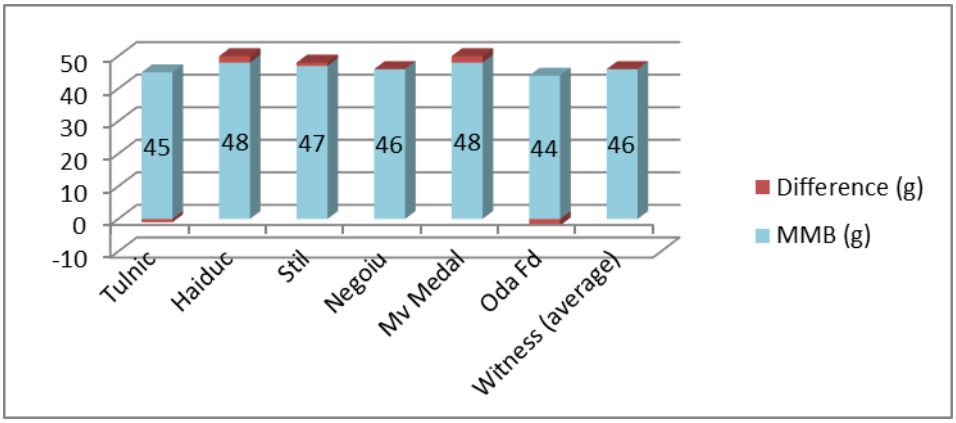

Figure 9. The influence of the pedo-climatic conditions over the Weight of 1000 grains (MMB) for triticale

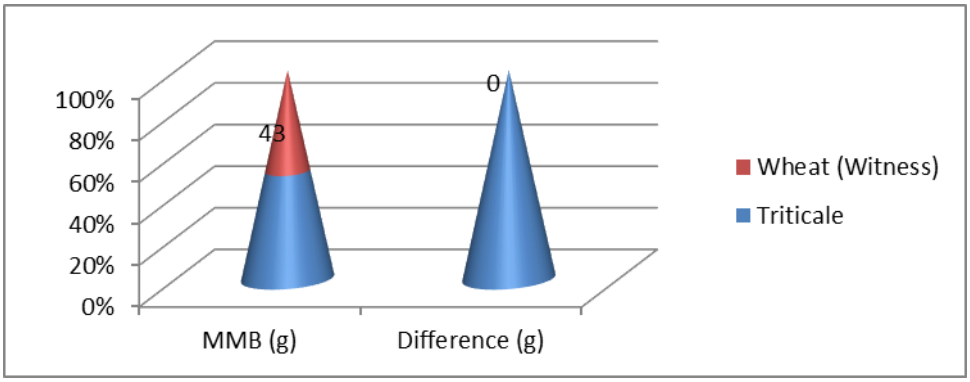

Figure 10. The influence of the pedo-climatic conditions over the Weight of 1000 grains (MMB) for triticale and wheat

The triticale types studied at S.C.D.C.B. Arad had a hectolitric mass between 73 kg/hl (Haiduc, Stttil, Negoia) and 74 kg/hl (Tulnic, MvMeda, OdaFd), without significant differences between them (Figure 11).

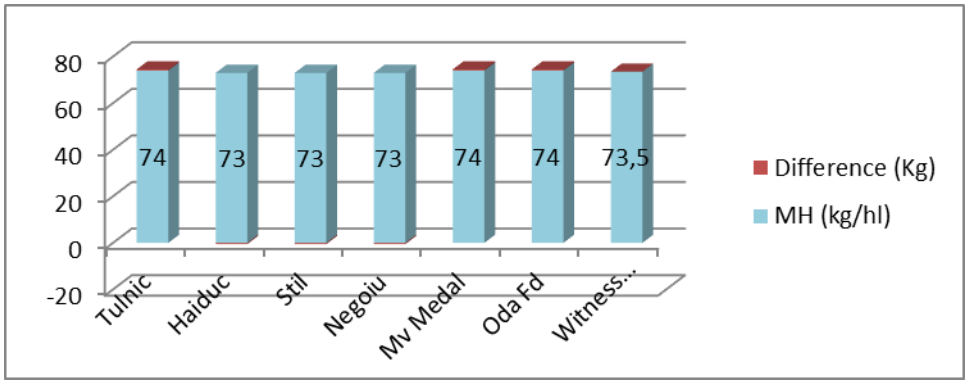

Figure 11. The influence of the pedo-climatic conditions over the hectolitric mass (MH) for triticale

By comparing the hectolitric mass of the triticale kernels with those of the wheat kernels it can be observed a difference of 3,5 kg/hl, which favors the wheat as the first option for bakery. The average hectoliter mass for wheat was 77 kg/hl, and for triticale, the average value was 73,5 kg/hl (Figure 12).

The growth and development of the triticale plants were good and lead to high kernel production registered per unit surface, with an average value of 7870 kg/ha. It is worth noting that Oda Fd and Stil types had the lowest grain productions, of 7480 kg/ha and 7750 kg/ha, respectively. The best adapted types were Haiduc and Negoiu, for which production values exceeded 8000 kg/ha, being 8160 kg/ha and 8050 kg/ha, respectively (Figure 13).

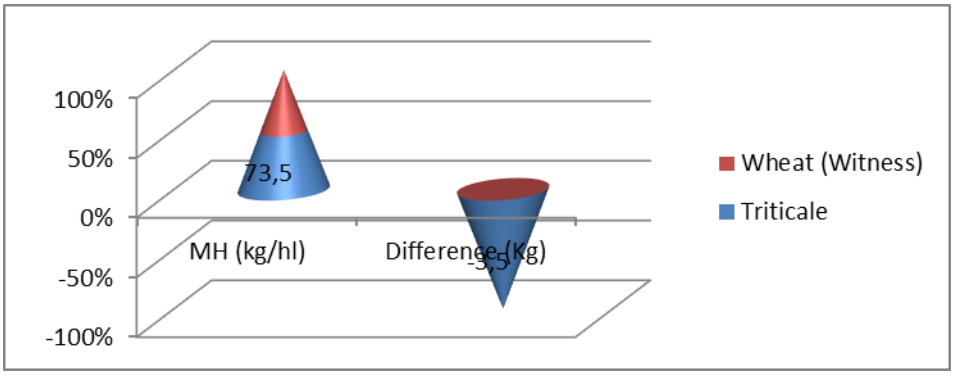

Figure 12. The influence of the pedo-climatic conditions over the hectolitric mass (MH) for triticale and wheat

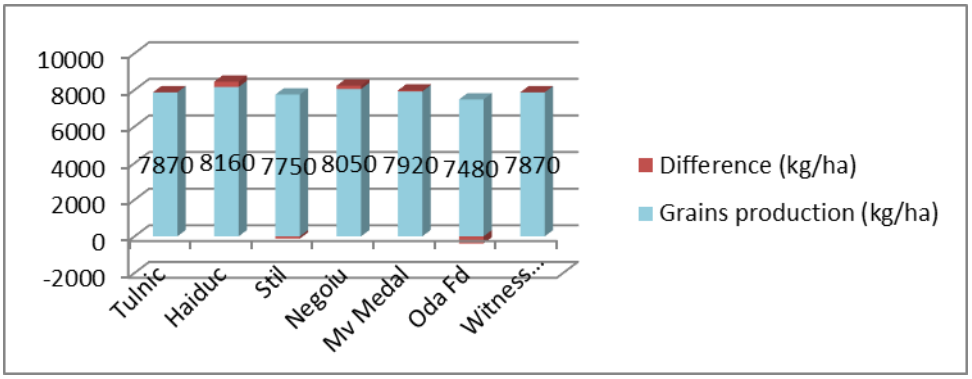

Figure 13. The influence of the pedo-climatic conditions over seed productions for triticale

On closer inspection of the grain productions for the two studied species, it can be observed that triticale have obtained better results than wheat, which recommends triticale for cultivation, especially as fodder for animals.

With an average grains production of 7870 kg/ha, triticale have exceeded the wheat, for which the average value was of 6000 kg/ha (Figure 14).

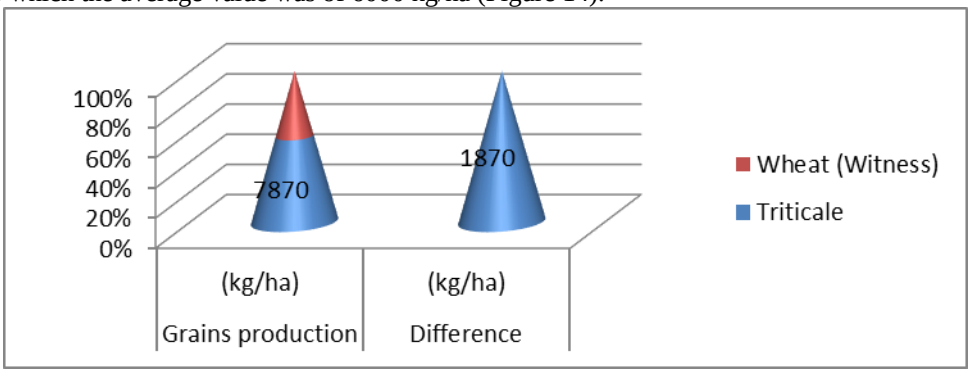

Figure 14. The influence of the pedo-climatic conditions over the seeds productions for triticale and wheat

The plant's vegetative mass was higher for triticale, given the average production of straws per unit surface (5510 kg/ha). The straws obtained after harvest had a weight between 5240 kg/ha for Oda Fd type and 5720 kg/ha for Haiduc type. Good results were obtained for Negoiu and MvMedal types, for which the vegetative mass harvested after threshing was of 5630 kg/ha and 5540 kg/ha, respectively (Figure 15).

The average percentage of proteins for triticale grains was between 11,4% for Stil type and 12,1% for Tulnic. To be noticed that Oda Fd type had a protein content of 12%, and MvMedal had a protein content of 11,9%.

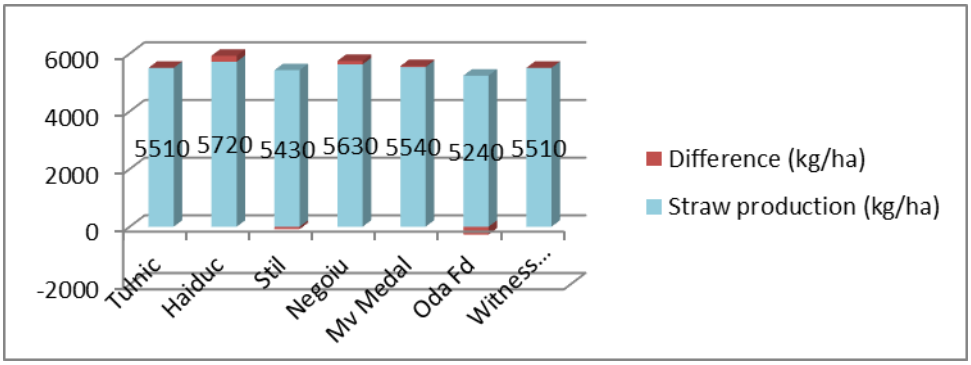

Figure 15. The influence of the pedo-climatic conditions over straw production for triticale

Haiduc and Negoiu types had 11,5% and 11,6% proteins, respectively, the values are smaller than those of the witness variant for which the average protein content in triticale kernels was 11,7% (Figure 16).

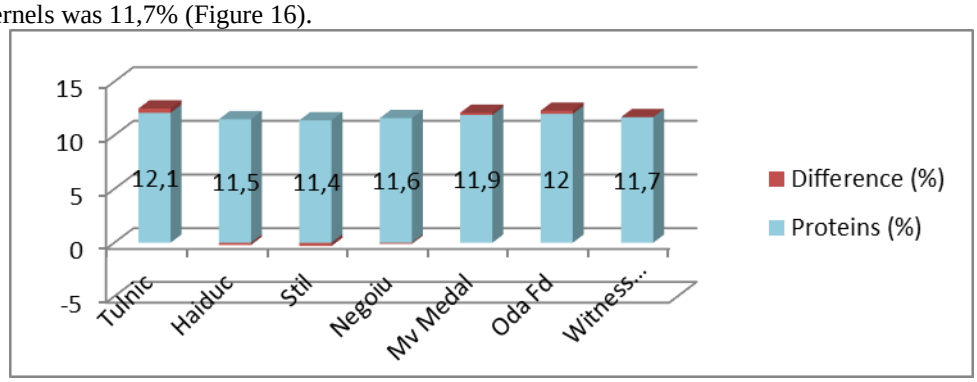

Figure 16. The influence of the pedo-climatic conditions over the protein content in grains for triticale

The protein content for wheat grains was on average 12%, exceeding by 0,3% the value for triticale (Figure 17).

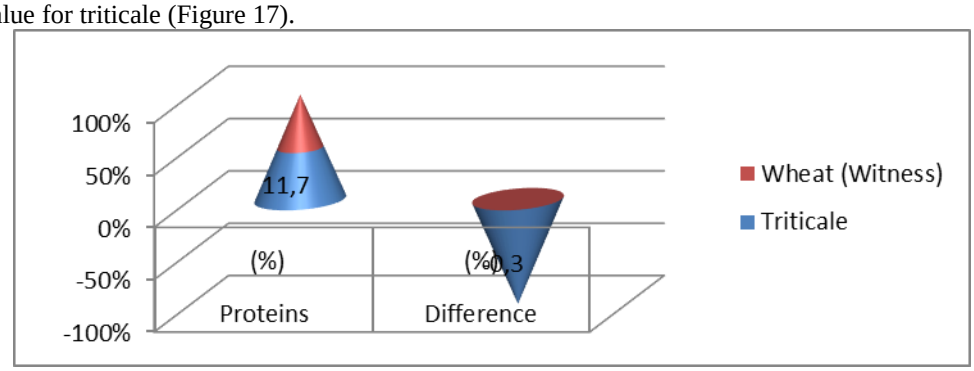

Figure 17. The influence of the pedo-climatic conditions over the protein content in grains for triticale and wheat

Similar to other straw cereals, the oil content in triticale kernels is low, for the present cases, the value is between 1,5% and 1,7% (Figure 18).

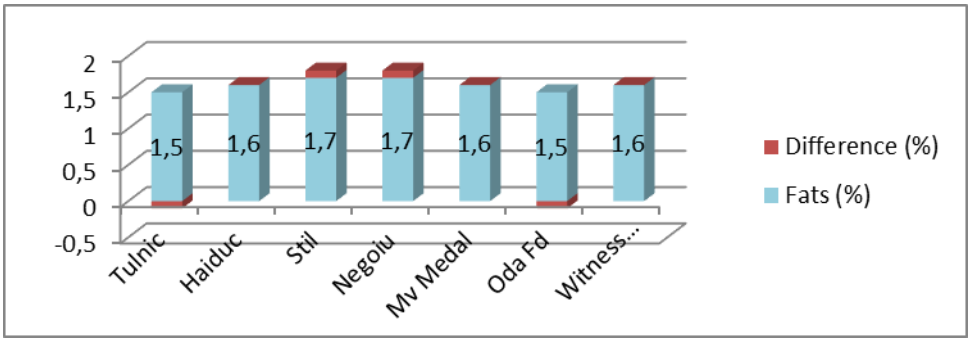

Figure 18. The influence of the pedo-climatic conditions over the fat content in grains for triticale

Compared to wheat, for which the kernels had on average 1,8% fat, triticale plants had with 0,2% less fat content, with a value of 1,6% (Figure 19).

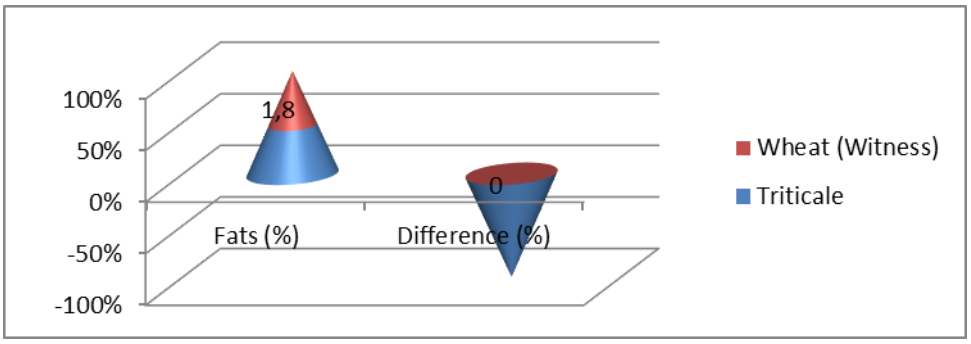

Figure 19. The influence of the pedo-climatic conditions over the fat content in grains for triticale and wheat

The studied types registered a very close starch content in their kernels, the values being between 62% for Stil type and 62,4% for Haiduc type (Figure 20).

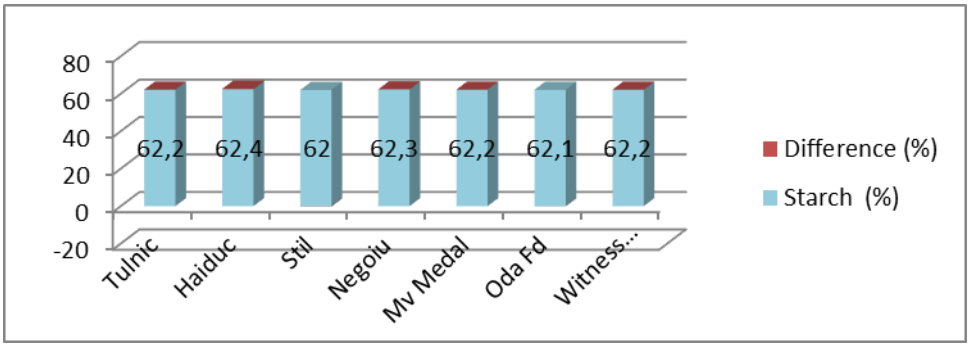

Figure 20. The influence of the pedo-climatic conditions over the starch content for triticale grains

In comparison with wheat grains, which had a starch percentage of 62,8%, it can be noted that triticale grains had 0,6% less polysaccharides, registering an average value of 62,2% (Figure 21).

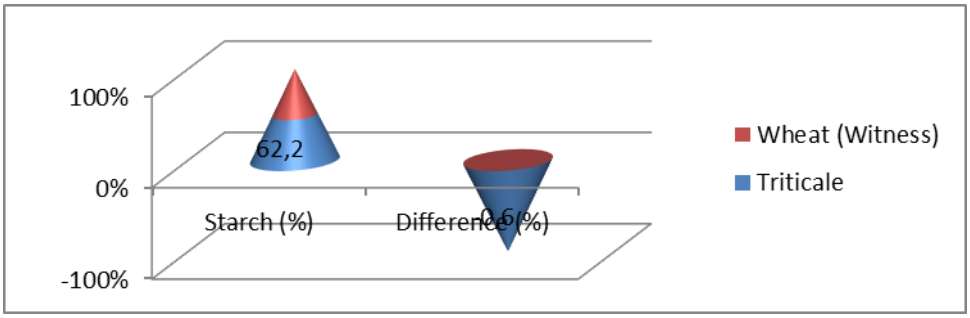

Figure 21. The influence of the pedo-climatic conditions over the starch content in triticale and wheat grains

Analyzing the behavior of the 6 triticale types in the pedo-climatic conditions from Arad, from an economic perspective, it can be affirmed its efficiency, the profits being between 4294 lei/ha (OdaFd) and 4958 lei/ha (Haiduc). Good results were obtained for the variants cultivated with Negoiu, obtaining a profit of 4848 lei/ha, and for those cultivated with MvMedal, for which the profit was 4721 lei/ha.

It is worth noticing the behavior of the Oda Fd and Stil types, for which the profit was 381 lei/ha and 117 lei/ha, respectively, less than the profit for the witness, but can be considered economically efficient as well. Tulnic type is well situated with a profit of 4673 lei/ha (Figure 22).

Both crops reached a good economic efficiency, with an average profit of 4675 lei/ha for triticale species, and 3900 lei/ha for wheat species.

The triticale types taken into study have highlighted the fact that this species has an economic efficiency that is superior to wheat, the profit value being higher by 775 lei/ha (Figure 23).

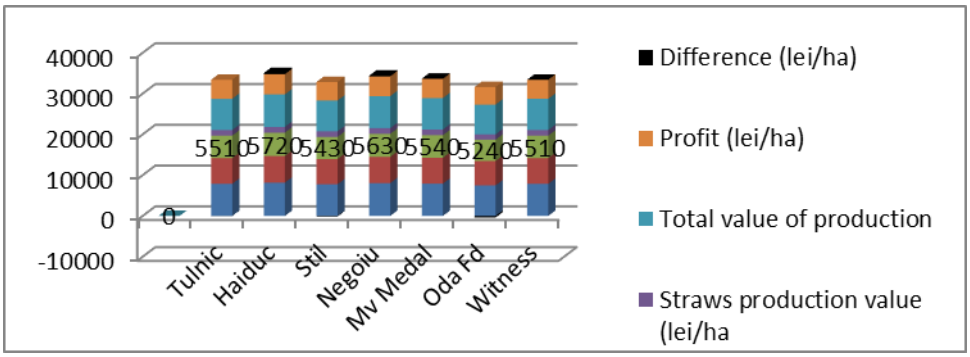

Figure 22. The influence of the pedo-climatic conditions over the economic efficiency of triticale

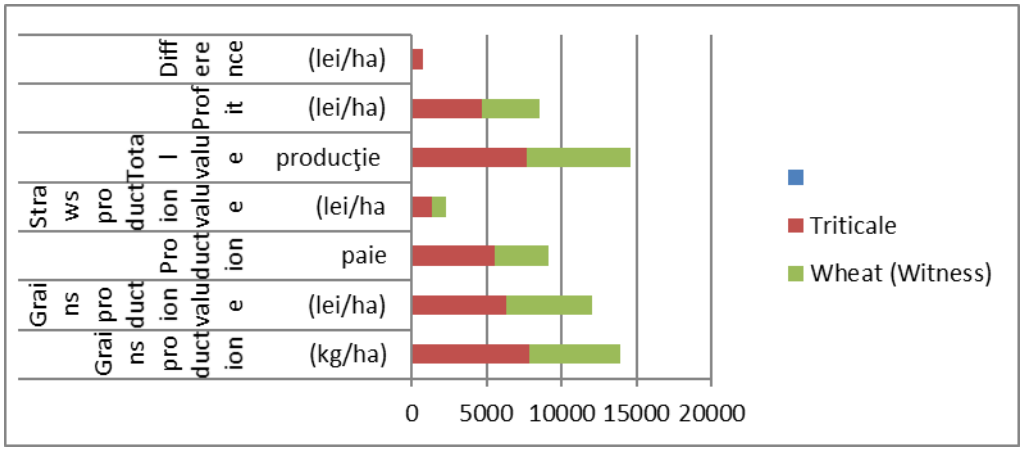

Figure 22. The influence of the pedo-climatic conditions over the economic efficiency of triticale and wheat

CONCLUSIONS

The cultivation of the 6 triticale types (*Triticosecale* Wittmack) in the soil and climate conditions from Arad area, has led to the obtaining of optimal morphological, biochemical and production characteristics for all experimental variants.

The average size of the triticale plants was 113,5 cm, evaluated as good, and the number of spikelets per ear had an average value of 31, which shows a good adaptability of the plants in the given environmental conditions.

High productions were obtained for all types, especially for Haiduc type which reported 8160 kg/ha quantity of grains per unit surface. In the pedo-climatic conditions from

Arad, Negoiu, MvMedal and Tulnic types registered productions of over 7800 kg/ha, proving themselves as viable variants for cultivation in this area.

The protein content (11,4-21,1%) and fat content (1,5-1,7%) were between normal limits for all types taken into study.

The starch content of the triticale grains recommends the studied types to be used in high proportions as animal fodder and in the starch industry.

From an economic standpoint, the best results were obtained for Haiduc type, which had a total production value of 7958 lei/ha and led to a profit of 4958 lei/ha, followed by Negoiu type with a total production value of 7848 lei/ha and a profit of 4848 lei.ha.

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