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Contemporary Agriculture
Vol. 67, No. 1, Pp. 51 - 57, 2018.

The Serbian Journal of Agricultural Sciences
ISSN (Online) 2466-4774 UDC: 63(497.1)(051)-“540.2”
www.contagri.info

Original scientific paper UDC: 631.572
DOI: 10.2478/contagri-2018-0008

CELLULOSE ACCUMULATION IN STRAW OF TRITICUM MONOCOCCUM L., TRITICUM DICOCCUM SCH. AND TRITICUM SPELTA L. IN ORGANIC FARMING CONDITIONS

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Summary: In a study conducted in the experimental field of the Agricultural University - Plovdiv accumulation of cellulose in straw of Triticum monococcum L., Triticum dicoccum Sch. and Triticum spelta L., has been tracked as a result of bio fertilizes application in organic farming conditions. The highest cellulose content was found in the straw of Triticum spelta L., followed by Triticum monococcum L. The least accumulation was found in the straw of Triticum dicoccum Sch. With few exceptions, the application of the investigated fertilizes, increases the content of cellulose in a leaf-stalked mass in Triticum dicoccum Sch. and Triticum spelta L. The opposite trend was observed in Triticum dicoccum Sch. A species reaction was found as a result of fertilization on accumulation of cellulose in straw.

Key words: Triticum monococcum L., Triticum dicoccum Sch, Triticum spelta L., organic farming, bio fertilizes, cellulose content

INTRODUCTION

Already well known ancient wheat species Triticum spelta L. (dinkel), Triticum monococcum L.(einkorn) and Triticum dicoccum Sch.(emmer) become more and more popular each year in Europe and all over the world.

Their production, in the last decades, is encouraged in relation to the preservation of the genetic resources and the biodiversity in agriculture. The tendencies in the biological agriculture and the consumption of healthy food products resulted in the ancient wheat species researches. It is considered that these species are predetermined for biological agriculture. Triticum dicoccum Sch. grows even in soils, poor in nutrients. In such a way, it supports the agricultural development of the poorer mountain regions in Turkey (Giuliani et al., 2009) and it is particularly appropriate for biological growing due to its identity (Wolfe et al. 2008).

The diversity of Triticum dicoccum Sch. is represented by 23 varieties. Most of the samples out of them are from var. farrum, var. pycnurum, var. rufum and var. compactomiegei. The wheat Triticum dicoccum Sch. is a tetraploid wheat (2n=28). It is known under the name Emmer and in Italy, it is called Farro (Stefanini, et.al. 2008). It is appropriate for growing even in soils, poor in nutrients in the mountain regions (Marino, et all., 2009) . The group of “ancient” wheats (Tr. monococcum L. , Tr. dicoccum Sch. and Tr. spelta L.) is appropriate to be used for scientific researches for finding of alternative sources of food with the growing interest in the organic agriculture and healthy eating (Bojnanska, and Francakova, 2002; Zaharieva, and Monneveux 2014).

Along with grain producing from these wheats, the straw is not so rough as Triticum aestivum L. or Hordeum sativum L. That makes it suitable as coarse fodder in the food compositions for feeding livestock.

The ability of these wheats to grow and develop on a poor in nutritional terms soils, makes them suitable for growing in mountain areas and non fertile soil (Giuliani et al., 2009)

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The use of different fertilizers contribute to increasing the yield and quality of grain, better development of leave-stem mass, in connection with better quality of the straw. Some authors (Vlahova et all., 2011; Vlahova, 2013) report for the influence of some bio fertilizers on quality indicators in other species.

The aim of the research is to investigate the cellulose accumulation in straw of Triticum spelta L., Triticum monococcum L. and Triticum dicoccum Sch.in organic farming conditions.

MATERIAL AND METHODS OF THE STUDY

The study was conducted at the experimental field in the Agroecological center - Demonstration center of organic farming the Agricultural University – Plovdiv (Bulgaria) during the 2014-2016 period. The Agroecological center is a member of IFOAM since 1993.

A two-factor field experiment, based on block method has been set in three replications and with a plot size of 10,5m^2 on soil type Mollic Fulvisols based on FAO, (FAO-UNESKO, 1990; Popova et al., 2010). Sowing was carried out in mid-October with seed rate of 500 g.s. / m^2, after a pepper as a predecessor. The main fertilization was carried out with organic fertilizer Agriorgan pellet at a dose of 1000 kg/ha.

The following factors have been studied: Factor A - wheat species A1 - Triticum dicoccum Sch .; A2 - Triticum spelta L.; A3 - Triticum monococcum L., and Factor B - Organic Fertilizers: B1 – Amalgerol; B2 – Lithovit; B3 - Baykal EM; B4 - Tryven. Soil fertilizing Agriorgan pellet - 1000 kg /ha for all variants of the experiment; Amalgerol, Lithovit, Baykal EM, Tryven – foliar fertilizers, sprayed during the vegetation of the wheats. Amalgerol® is a liquid fertilizer rich in hydrocarbons and natural plant growth hormones. Contains extracts from seaweed, distilled paraffin oil, vegetable oils, distilled herbal extracts. Stimulates the growth of plants, increases the quality and quantity of crop yields in grain production.

Lithovit contains 79.19% ($CaCO_3$) Calcium Carbonate, 4.62% ($MgCO_3$) Magnesium Carbonate, 1.31% (Fe) Iron. It is applied as leaf manure for fodder crops, trenches, meadows and pastures.

Baykal EM - probiotic product containing useful microorganisms (lactic acid bacteria, yeast, bifidobacteria, ferments and spore bacteria) that are antagonists of pathogenic and conditionally pathogenic microflora. The preparation contains a large group of microorganisms that live in a mode of interaction with a nutrient medium.

Tryven contains Nitrogen (N) total 24.4%, Ammonium Nitrogen (N) 2.60%, Nitrate Nitrogen <0.01%, Carbamide Nitrogen 4.47%, Organic Nitrogen 17.3%, Phosphorus (P_2O_5) water-soluble 17.2%, potassium (K_2O) water-soluble 7.42%. It is a complex mixture of NPK intended for leaf-feeding use.

Agriorgan Pellet - organic fertilizer made of sheep fertilizer, enriched with microorganisms and microelements. Contains: Total Nitrogen (N) - 3.0%, Organic Nitrogen (N) - 2.5%, Phosphorous Oxide (P_2O_5) Total - 3.0%, Organic (K_2O) carbon (C) - 28.5%, Humic acids - 6.0%

The biochemical analysis of the straw for cellulose content is made by Ŝchtoman and Heneberg method (Koleva – Valkova, et al., 2016).

The statistical processing of the experimental data was performed through Duncan's test.

RESULTS

Meteorological conditions in the experimental period

The vegetation year 2014-2015 is characterized by being relatively warm, with temperature values above the norm in long-term period (Fig. 1).

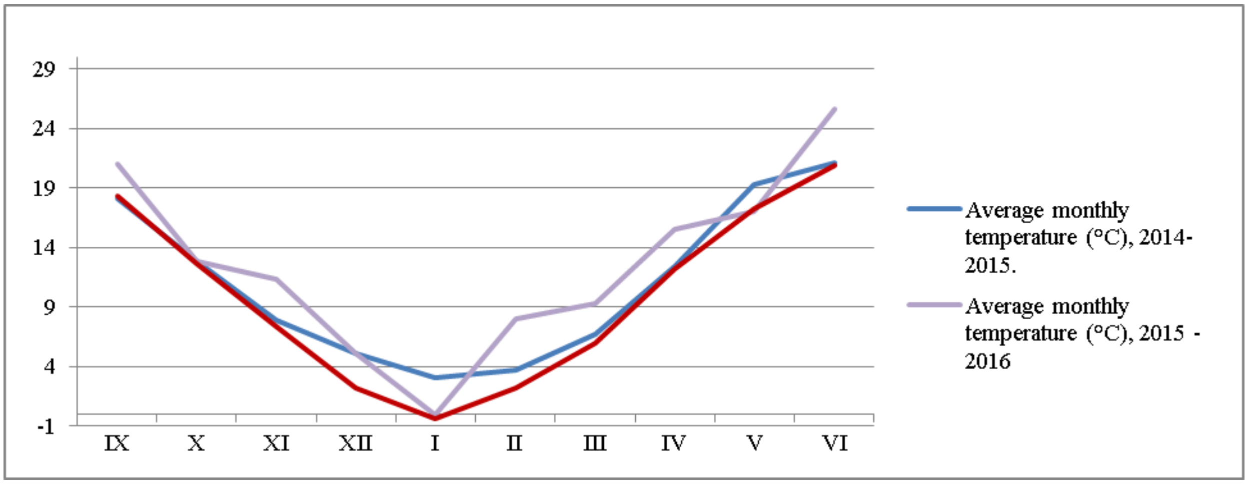

Figure 1. Average monthly temperature (°C), 2014 -2016.

The rainfalls were above the norm, with the exception of January and April, which determined the year as relatively humid (Fig. 2). The sowing for the experiment was performed on 16.X.2014 and was followed by heavy rainfall in the third ten-day period of the month (116 mm/m^2).

The heavy rainfalls and temperature value, being slightly above the norm for the month (12,8°C), allowed for the plants to germinate for about 13 days. The winter period was accompanied by high values of the rainfall and positive temperatures, above the norms. As a result of the above, the plants passed the winter successfully.

The spring vegetation started in March in the conditions of heavy rainfalls (138 mm/m^2) with values of 94 mm/m^2 above the norm. The above conditions had positive impact over the formation of the structural elements of the panicle, which is expected in the period March – April (phenophases tillerering-stem elongation with the studied species).

The second vegetation year 2015-2016, like the previous one, was characterized as relatively warm, with temperature values above the norms and good quantities of rainfall. The heavy rainfalls in October resulted in the normal germination of the sowing. The combination of these conditions (temperature and humidity) allowed for the normal sowing garnishment during germination and successful strengthening of the plants for the winter period.

The temperature values, above the norm for the period December – February, allowed the plants to successfully spend the winter.

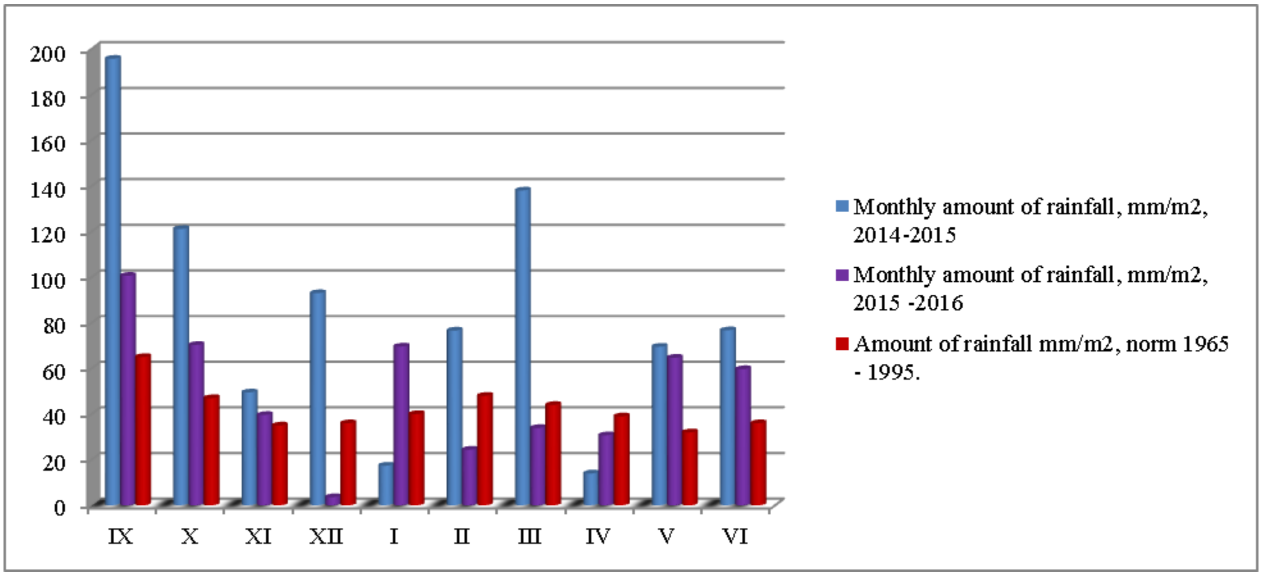

Figure 2. Amount of the rainfall during the experimental period (mm/m^2), 2014 – 2016.

Table 1. Cellulose content at Triticum monococcum L., Triticum spelta L. and Triticum dicoccum Sch. average for the experimental period.

Variants	Cellulose content, %		
	Triticum monococcum L.	Triticum spelta L.	Triticum dicoccum Sch.
Control	42,82a	41,51a	41,43a
Amalgerol	43,10a	43,49a	43,52b
Lithovit	40,34a	48,54c	40,60a
Baykal EM	43,46a	41,33a	43,93b
Tryven	45,98b	44,48b	40,76a

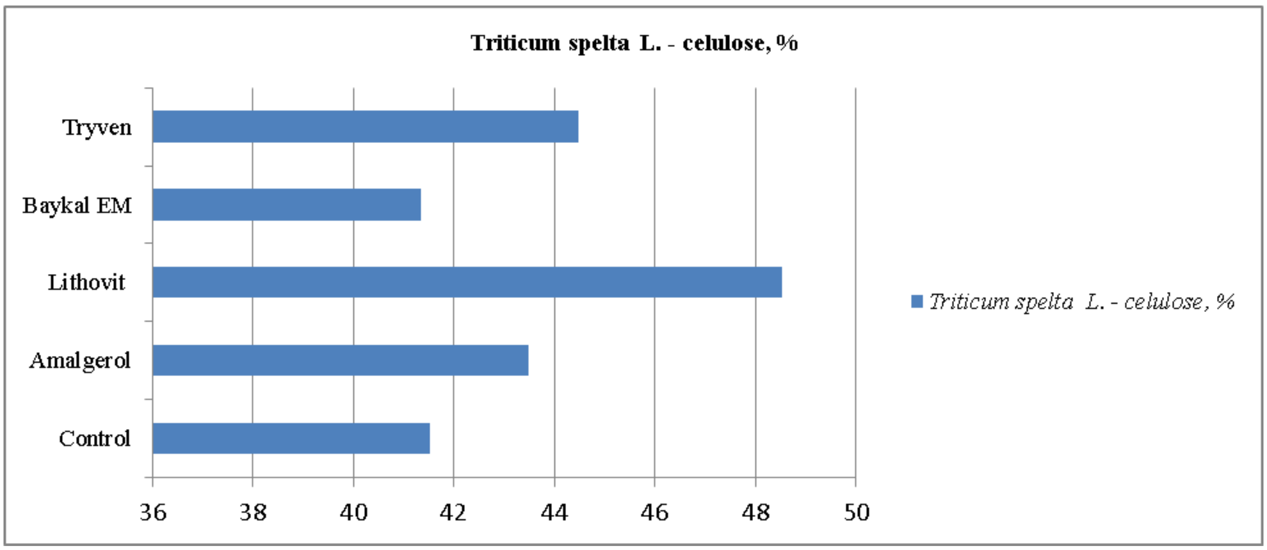

Figure 3. Cellulose content (%) at Triticum spelta L.

Cellulose content in the straw of Triticum spelta L., Triticum monococcum L. and Triticum dicoccum Sch., is presented on table 1. For all three species the values range from 40,34 – 48,54 % for different impacts, but compared with the data on the cellulose content of common wheat up to 40% (Sun, 2005), there is a slight excess in the values, indicating that the straw from these crops can be used as a substitute for wheat.

By crops (as shown in the graphs) the highest content of cellulose was recorded at Triticum spelta L. as a result of treatment with Lithovit – 48,54%, (Fig. 3) and lowest as a result of the same treatment for Triticum monococcum L., which is also the lowest value for this indicator for all three crops, and makes it the most suitable for feeding animals.

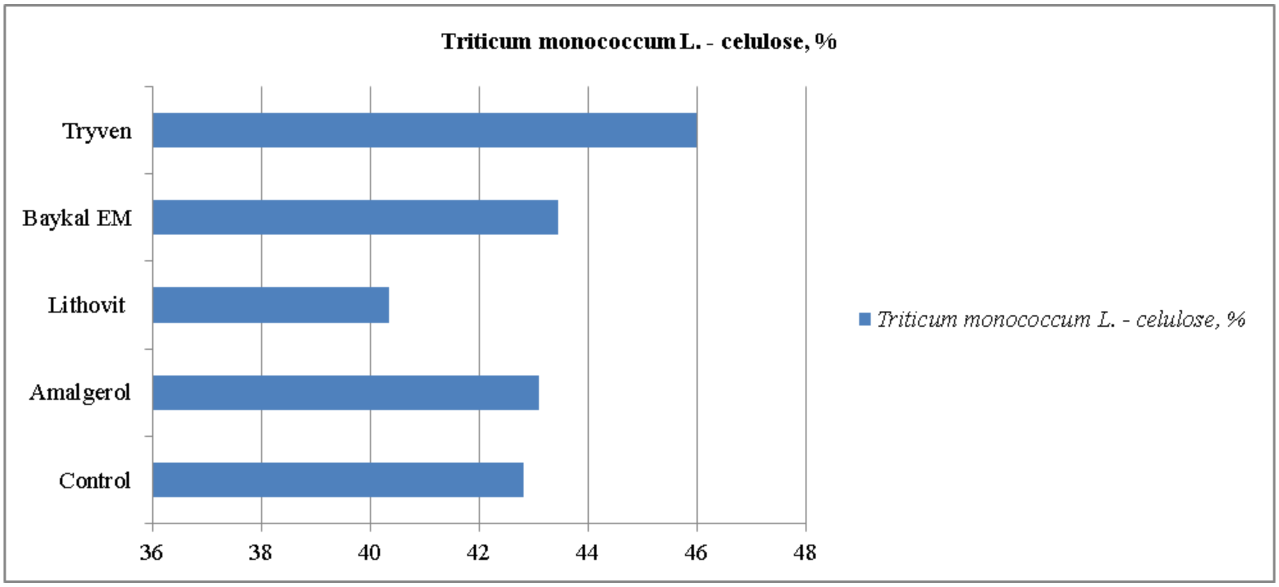

Figure 4. Cellulose content (%) at Triticum monococcum L.

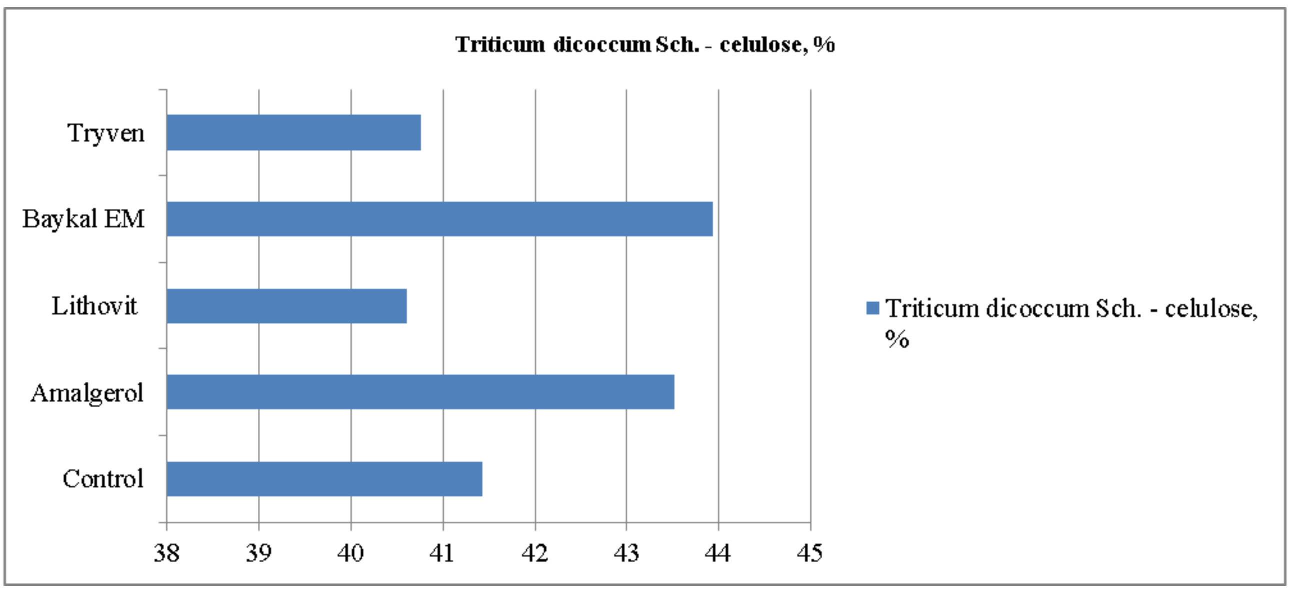

Figure 5. Cellulose content (%) at Triticum dicoccum Sch.

DISCUSSION

During the first year, for all three crops, cellulose content values slightly increased compared to 2015. There is some tendency as the previous year with the highest cellulose content is the straw of Triticum spelta L., followed by Triticum monococcum L.

Generally, the lowest value of cellulose for a second consecutive year is found in Triticum dicoccum Sch. Fertilizers application, with a few exceptions, increases the cellulose content in the leaf-stem mass of Triticum spelta L., and the Triticum monococcum L. The opposite trend was observed at Triticum dicoccum Sch. Another interesting fact in this year is that Baykal EM application increases the cellulose content of both - Triticum monococcum L. and Triticum dicoccum Sch., but does not change the same for Triticum spelta L. Amalgerol treatment only, leads to increasing values for all three species - Triticum monococcum L. (43,10%), Triticum dicoccum Sch. (43,52%) and Triticum spelta L., (43,49%) for the three studied cultures and this is statistically proven. On the other hand, the use of growth regulators increases the content of cellulose in Triticum monococcum L. and Triticum spelta L., and has a controversial effect on Triticum dicoccum Sch.

During the second year also there is no culture where the treatment leads to increasing in cellulose content, but in general Triticum dicoccum Sch. is least affected by treatment.

At Triticum spelta L. all tested fertilizers increased the cellulose content compared to the control, the most significant increasing is when Lithovit is applied (48,54%) and the lowest at Baykal EM (41,33%), Fig. 3.

As the above reported results there is species reaction in regard to cellulose accumulation as a result of fertilization, namely - it reduces the cellulose in Triticum dicoccum Sch., and increases with Triticum monococcum L.

As it's seen from the graphs for this year, the strongest effect at Triticum monococcum L. is registered at Tryven treatment (45,98%), at Triticum spelta L., with Lithovit (48,54%) and at Triticum dicoccum Sch. with Baykal EM - 43,93% (Fig. 5).

CONCLUSION

The highest cellulose content was recorded at Triticum spelta L. as a result of treatment with Lithovit 48,54%, and lowest at Triticum monococcum L.at the same treatment, which is also the lowest value for this indicator for all three crops, which makes this straw most appropriate to feed animals.

For all three species, the values range from 40,34 to 48,54% for different impacts, but compared to the data of common wheat up to 40%, there is a slight excess in the values, which indicates that the straw from these crops can be used as a substitute of wheat straw.

Organic fertilizers application, with few exceptions, increases cellulose content at Triticum spelta L. and Triticum monococcum L. The opposite trend was observed at Triticum dicoccum Sch.

ACKNOWLEDGEMENTS

The survey was part of the results under project № 10-14 within the period 2014-2016 financed by the Research Centre of the Agricultural University – Plovdiv, Bulgaria.

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Received / Primljen: 21.06.2017.
Accepted / Prihvaćen: 24.12.2017.