RESULTS REGARDING THE BIOMASS YIELD AT TRITICALE UNDER DIFFERENT TECHNOLOGICAL CONDITIONS

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Abstract

Triticale is a man-made crop obtained by crossing the wheat with rye. Among the characteristics that make this species of interest are the high yields of grains and biomass in a great diversity of climatic conditions and crop technologies with low inputs. The aim of the paper is to present the dry biomass yield and biomass moisture content at different varieties of triticale studied under different soil tillage conditions, different preceding crops, and different nitrogen application variants. In this respect, there were studied two varieties of triticale (Gorun 1 and Tulus) under the following technological conditions: two soil tillage, respectively ploughing and harrowing; two preceding crop, respectively sunflower and maize; six nitrogen application variants, respectively 0+0+0 kg.ha⁻¹, 40+40+40 kg.ha⁻¹, 40+80+0 kg.ha⁻¹, 0+40+80 kg.ha⁻¹, 0+80+40 kg.ha⁻¹, and 0+120+0 kg.ha⁻¹. Researches were performed in the agricultural year 2013-2014, in field experiments located in South Romania, respectively at Moara Domneasca Experimental Farm (44°29′44″ North latitude and 26°15′28.5″ East longitude) belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest, on a reddish preluvosoil. The biomass determinations were performed at early dough growing stage. In the case of sunflower as preceding crop, the highest dry biomass yields were obtained for the nitrogen fertilization of type 40+40+40. For the soil tillage harrowing, when sunflower is the preceding crop for triticale, it was remarked also the nitrogen fertilization variant of type 40+80+0. In the case of maize as preceding crop and the soil tillage harrowing, the highest dry biomass yields were obtained for the nitrogen fertilization of type 0+120+0.

Key words: triticale, dry biomass, soil tillage, preceding crop, nitrogen.

Introduction

Triticale (Triticosecale Wittmack) is a man-made crop obtained by crossing the wheat with rye. It was designed in order to obtain a cereal which combines the good quality and high yielding capacity which is specific for the wheat with the tolerance to abiotic and biotic stress factors which is specific for the rye. Among the characteristics that make this species of interest are the high yields of grains and biomass in a great diversity of climatic conditions and crop technologies with low inputs. Triticale is able to resist some unfavourable biotic and abiotic environmental factors and thus produce good yield in marginal regions (Martinek et al., 2008; Lalević et al., 2012). Drought and frost tolerance are the primary advantages that triticale has over the other cereal crops and thus it reduces weather risk (Loha et al., 2007). In the specific growing conditions from South Romania this species is used for grain yields but also for producing biomass. The area from South Romania provides favourable growing conditions for triticale (Dumbrava et al., 2014). Triticale biomass was firstly of interest as fodder, but it has become also of interest as raw material for producing biogas (Ion et al., 2014). For biogas production, triticale should be harvested in the vegetation stage “grain in the milk stage” to “grain in the dough stage” (Amon et al., 2007). Understanding the
fertilization effect has been a continuous endeavour toward improving fertilization technology and strategy to reduce the negative impacts to increase the crop yield (Janušauskaitė, 2013). Nitrogen fertiliser application at different plant stages has an essential effect on the height of stems and grain yield quality (Alaru, 2004), and it is supposed to have an essential effect on the dry biomass yield. Also an essential effect on the dry biomass yield it is supposed to have the soil tillage and preceding crop.

The aim of the paper is to present the dry biomass yield and biomass moisture content at different varieties of triticale studied under different soil tillage conditions, different preceding crops, and different nitrogen application variants.

**Materials and methods**

Researches were performed in the agricultural year 2013/2014 in field experiments located in South Romania, these being implemented in the specific conditions from Moara Domneasca Experimental Farm (44°29′44″ North latitude and 26°15′28.5″ East longitude) belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest. In the studied area, the specific soil is reddish preluvosoil. In this area, during the nine months of interest for triticale, respectively from September 2013 to June 2014, the average temperature was 9.5°C, while the multiannual average temperature is 8.5°C. The sum of rainfall was 572 mm, while the multiannual average rainfall is 408.9 mm. There were studied two varieties of triticale (Tulus and Gorun 1) under the following conditions: two soil tillage, respectively ploughing and harrowing; two preceding crops, respectively sunflower and maize; six nitrogen application variants, respectively 0+0+0 kg.ha⁻¹, 40+40+40 kg.ha⁻¹, 40+80+0 kg.ha⁻¹, 0+40+80 kg.ha⁻¹, 0+80+40 kg.ha⁻¹, and 0+120+0 kg.ha⁻¹. For the experimental variants having maize as preceding crop, we were not able to take valid samples of plants from the variants with soil tillage ploughing because of the high plant heterogeneity due to the poor and staggered plant emergence. For the variants with ploughing as soil tillage, one harrowing work was performed on 26th of September 2013, and the ploughing was performed at a depth of 18 cm two days later, on 28th of September 2013. For the variants with harrowing as soil tillage, two harrowing works were performed on 26th of September 2013, at a depth of 12 cm. Soil bed preparation was performed on 29th of October 2013, with a seed bed cultivator with two passages for the variants with ploughing and with one passage for the variants with harrowing. The sowing was performed in the same day as seed bed preparation, at 12.5 cm row spacing and at a density of 600 germinal seeds per square meter. Nitrogen applications were the following: first application in the autumn, before seed bed preparation (on 29th of October, 2013); second application in the spring, in the tillering growing stage (on 14th of March, 2014); third application in the spring, in the two nodes growing stage (on 26th of April, 2014). In the spring, the weed control was realised by applying the herbicide Dicopur Top 464 SL (344 g/l acid 2.4 D from SDMA + 120 g/l dicamba) at a rate of 1 l.ha⁻¹, the treatment being performed on 2nd of April 2014. The biomass determinations were performed at early dough growing stage. In this respect, the plants from 0.5 square meters, respectively four rows of plants on 1 m length were cut at soil level and were weighed immediately in the field. This procedure was performed in four replications for each experimental variant. For each experimental variant, ten average plants were taken and weighed immediately in the field and then dried in the laboratory into the oven at 80°C for 24 hours for determining the dry biomass and moisture content. The obtained data were statistically processed by analyses of variance. The yield of dry matter was calculated in tons.ha⁻¹ and represents actually the yield of above-ground biomass.

**Results and discussion**

The highest dry biomass yield (expressed as above-ground biomass) was registered for Tulus variety (17.97 t.ha⁻¹) when the preceding crop was sunflower, the soil tillage was ploughing,
and the nitrogen fertilization was 0+40+80 (0 kg of N.ha\(^{-1}\) in autumn, 40 kg of N.ha\(^{-1}\) in the tillering growing stage, and 80 kg of N.ha\(^{-1}\) in the two nodes growing stage). But, for the Gorun 1 variety, the highest dry biomass yield (19.16 t.ha\(^{-1}\)) was registered when the preceding crop was maize, the soil tillage was harrowing, and the nitrogen fertilization was 0+120+0 (Figure 1). These data put into evidence the different reaction of the triticale variety to the technological measures. This idea is sustained also by the average values of the dry biomass yield at different nitrogen application variants. Thus, when the preceding crop was sunflower, the average dry biomass registered at different nitrogen application variants at Tulus was higher when the soil tillage was ploughing (15.45 t.ha\(^{-1}\)) compared to harrowing (13.32 t.ha\(^{-1}\)), while at Gorun 1 on the contrary the average dry biomass was higher when the soil tillage was harrowing (13.92 t.ha\(^{-1}\)) compared to ploughing (12.97 t.ha\(^{-1}\)). In the variants with sunflower as preceding crop and when the soil tillage was ploughing, the highest dry biomass yields for Tulus variety was registered at nitrogen fertilization of 0+40+80 (17.97 t.ha\(^{-1}\)) and of 40+40+40 (17.60 t.ha\(^{-1}\)), in both cases with differences very significant compared to control represented by unfertilised variant (0+0+0). For Gorun 1 variety, the highest dry biomass yield was registered at nitrogen fertilization of 40+40+40 (16.04 t.ha\(^{-1}\)), with a difference significant compared to unfertilised variant (0+0+0). The high dry biomass yields registered at an application of nitrogen of 40+40+40 (autumn+early spring + later spring) put into evidence the importance of a well balanced nitrogen fertilization for triticale when the sunflower is the preceding crop and when the soil tillage is ploughing.

In the variants with sunflower as preceding crop and when the soil tillage was harrowing, the highest dry biomass yields for both triticale varieties (Tulus and Gorun 1) were registered at nitrogen fertilization of 40+80+0 (14.74 t.ha\(^{-1}\) for Tulus and 18.05 t.ha\(^{-1}\) for Gorun 1) and of 40+40+40 (14.56 t.ha\(^{-1}\) for Tulus and 16.83 t.ha\(^{-1}\) for Gorun 1). For both varieties and nitrogen fertilization variants the differences compared to unfertilised variant (0+0+0) were very significant. Compared to Gorun 1, at Tulus the difference very significant compared to unfertilised variant was registered also at nitrogen fertilization of 0+80+40 (15.64 t.ha\(^{-1}\)). In the variants with maize as preceding crop and when the soil tillage was harrowing, the highest dry biomass yields for both triticale varieties were registered at nitrogen fertilization of 0+120+0 (14.54 t.ha\(^{-1}\) for Tulus and 19.16 t.ha\(^{-1}\) for Gorun 1), with differences very significant compared to unfertilised variant (0+0+0). This means that after maize as preceding crop, the highest dry biomass yields were registered when the nitrogen was applied in one application of 120 kg.ha\(^{-1}\), early in spring (in the tillering growing stage), without nitrogen application in autumn or later in spring (in the two nodes growing stage).

The nitrogen fertilization variant of 0+40+80 determined the smallest dry biomass yields when the soil tillage was harrowing at both triticale varieties for sunflower as preceding crop (11.15 t.ha\(^{-1}\) for Tulus and 9.98 t.ha\(^{-1}\) for Gorun 1), and at Gorun 1 also for maize as preceding crop (13.76 t.ha\(^{-1}\)). These small dry biomass yields are determined by the lack of nitrogen in the autumn, less nitrogen applied early in spring (in the tillering growing stage) and the less efficient use of the high nitrogen rate applied later in spring (in the two nodes growing stage).
Figure 1. Dry biomass yield at Tulus and Gorun 1 triticale varieties under different soil tillage, preceding crops and nitrogen application variants

Nitrogen application of 0+40+80 with soil tillage harrowing and sunflower as preceding crop determined the highest values of the biomass moisture content for both studied varieties (Tulus and Gorun 1), respectively 49.42% for Tulus and 47.86% for Gorun 1. Also a high value of the biomass moisture content was registered under the same experimental conditions for maize as preceding crop, respectively 41.16% for Tulus and 40.85% for Gorun 1 (Figure 2). This is explained by the fact that the high nitrogen rate applied late in spring (in the two nodes growing stage) keeps the plants green, respectively the vegetative plant components. The smallest values of the biomass moisture content (respectively the driest plants) were registered for both triticale varieties when the preceding crop was sunflower and when the soil tillage was ploughing, but at nitrogen application of 0+80+40 for Tulus variety (22.59%) and at nitrogen application of 40+40+40 for Gorun 1 variety (19.26%). It has to be emphasised that also for Gorun 1 variety the nitrogen application of 0+80+40 with soil tillage ploughing determined a small value of the biomass moisture content, respectively 22.74% (Figure 2).
When the preceding crop was sunflower, for both triticale varieties the average biomass moisture content was smaller when the soil tillage was ploughing than when the soil tillage was harrowing. When the soil tillage was harrowing, for both triticale varieties the average biomass moisture content was smaller when the preceding crop was maize than when the preceding crop was sunflower.

Figure 2. Biomass moisture content at Tulus and Gorun 1 triticale varieties under different soil tillage, preceding crops and nitrogen application variants

**Conclusion**

Taking into account the data we have obtained one can conclude that triticale varieties react different to the technological measures.

In the case of sunflower as preceding crop for triticale, the highest dry biomass yields were obtained for the nitrogen fertilization of type 40+40+40 (autumn + early spring + later spring) both for soil tillage ploughing and harrowing. For the soil tillage harrowing, when sunflower is the preceding crop for triticale, it was remarked also the nitrogen fertilization variant of type 40+80+0.
In the case of maize as preceding crop for triticale and the soil tillage harrowing, the highest dry biomass yields were obtained for the nitrogen fertilization of type 0+120+0. In the case of soil tillage harrowing, the nitrogen fertilization variant of 0+40+80 determined the smallest dry biomass yields, this being a consequence of the lack of nitrogen in the autumn, less nitrogen applied early in spring (in the tillering growing stage), and less efficient use of the high nitrogen rate applied later in spring (in the two nodes growing stage). Nitrogen fertilization variant of 0+40+80, with high nitrogen rate applied later in spring (in the two nodes growing stage), kept the plants green, which determined the highest values of the biomass moisture.

Nitrogen fertilization variant of 0+80+40, in the case of soil tillage ploughing and with sunflower as preceding crop determined the smallest values of the biomass moisture (respectively the driest plants).

In the case of sunflower as preceding crop, the average biomass moisture content was smaller when the soil tillage was ploughing than when the soil tillage was harrowing.

In the case of soil tillage harrowing, the average biomass moisture content was smaller when the preceding crop was maize than when the preceding crop was sunflower.

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