

## RESULTS REGARDING BIOMASS YIELD AT SUNFLOWER UNDER DIFFERENT TECHNOLOGICAL CONDITIONS

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### ABSTRACT

Crop biomass is an important source of renewable energy and it is used by the mankind from the ancient times. It was used mainly for producing heat, but recently it is also of interest as source of bioethanol, biodiesel, biogas, and even electricity. Nowadays, we are more and more interested in so called energy crops, including here the crops used for producing biomass. The specific crop technology for these energy crops is of great importance for producing biomass in an efficient way. Sunflower is one of the energy crops which are of interest for its above-ground biomass that could be used as substrate for producing biogas. Considering these matters, the aim of the present paper is to present the biomass yield obtained at an assortment of five sunflower hybrids under different preceding crop conditions (triticale with harrowing as soil tillage, maize with harrowing as soil tillage, and maize with ploughing as soil tillage) and row spacing conditions (70 cm, 50 cm, and twin-rows of 70/40 cm). For accomplishing this aim, a field experiment was performed in 2015 which was located in South Romania, respectively in the specific conditions from Moara Domneasca Experimental Farm belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest. Determinations of fresh and dry biomass were performed in the early dough - dough plant growth stage. For biomass purposes, the grower has to choose a sunflower hybrid with a high potential to produce biomass among other characteristic, but also he has to use a proper crop technology within which the preceding crop and row spacing are important elements.

**Key words:** Sunflower, Biomass, Yield, Preceding crop, Row spacing

### INTRODUCTION

Biomass could be defined as a form of energy storage whose major peculiarity is that to be renewable. Starting from this idea, the biomass that was used by humankind as source of energy since ancient times has become of great importance in the present context of global warming and searching for alternative ways of energy.

Biomass crops can take many forms and can be converted to a number of different products (Alexopoulou and Kretschmer, 2011). Concerning the use of crop biomass for energy purposes, this is of interest either as crop residues or as energy crops especially grown to accomplish this purpose.

Among the energy crops, sunflower could be used as a source of lignocelluloses biomass (Ziebell et al., 2013; Ion et al., 2014), which could be used as substrate for biogas

production. In this respect, sunflower offers an advantage as its oil produces a higher methane content in biogas than other biogas crops (Hahn and Ganssmann, 2008). Also, sunflower is of interest because it could be characterized as being a crop tolerating the drought and succeeding under limited input conditions (Ion et al., 2015), and having the capacity to supply important yields of above-ground dry biomass, usually of 10-15 tons.ha<sup>-1</sup>, reaching even 20 tons.ha<sup>-1</sup> (Stefan et al., 2008).

But, one of the important conditions to produce biomass in an efficient way is to use the most appropriate cultivation techniques (Balodis et al., 2011; Basa et al., 2014; Beg et al., 2007; Ion et al., 2014). There are several technological measures with great impact on the biomass production. Thus, apart from choosing the most appropriate sunflower hybrid according to the growing and technological conditions, one can consider the preceding crop and the row spacing.

Energy crops for biogas production need to be grown in sustainable crop rotations (Amon et al., 2007; Hahn and Ganssmann, 2008). Sunflower is one of the energy crops which could be included into the crop rotations in view to assure its sustainability.

Diepenbrock et al. (2001) found in 1996 and 1998 that the above-ground biomass increased significantly with increasing row spacing, but in 1997, however, the differences between the row spacing were small. Sunflower can be manipulated over a wide range of plant populations and row spacing without seriously affecting yield (Vijayalakshmi et al., 1975). Nevertheless, the experimental results show that different planting patterns sometimes produced higher yield, but not always (Zarea et al., 2005). Also, lodging increased with wider row spacing (Holt and Zentner, 1985). All these findings reveal the fact that there are several implications of row spacing but not always the results are very clear, which means that this subject needs further investigations.

The aim of the present paper is to present the biomass yield obtained at an assortment of five sunflower hybrids under different preceding crops (triticale with harrowing as soil tillage, maize with harrowing as soil tillage, and maize with ploughing as soil tillage) and row spacing conditions (70 cm, 50 cm, and twin-rows of 70/40 cm).

## **MATERIALS AND METHODS**

Researches were performed in a field experiment in the year 2015, which was located in South Romania, respectively in the specific conditions from Moara Domneasca Experimental Farm (44°29' N latitude and 26°15' E longitude) belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

The specific soil for Moara Domneasca area is reddish preluvosoil, which is characterized by a humus content of 2.2-2.8%, clay loam texture, and pH of 6.2-6.6. Taking into account the growing period of sunflower in this area (April-August), this period is characterized by the multiannual average temperature of 18.5°C and by the multiannual average rainfall of 313.2 mm. In the year 2015, the growing period of sunflower in the studying area was characterized by the average temperature of 19.2°C and the sum of rainfall of 237 mm. This means that the year 2015 can be characterized as being warmer and drier than normal years.

Five sunflower hybrids were studied, respectively: Favorit, Performer, LG56.62, P64LE19, and Pro 144. Each hybrid was studied under three preceding crop conditions (triticale with harrowing as soil tillage, maize with harrowing as soil tillage, and maize with ploughing as soil tillage) and under three row spacing (70 cm, 50 cm, and twin-rows of 70/40 cm). The total area of the field experiment was of 1,640 m<sup>2</sup>.

Soil tillage consisted in ploughing performed on 10<sup>th</sup> of November 2014, one harrowing work performed on 14<sup>th</sup> of April 2015, and seedbed preparation performed on 21<sup>st</sup> of April 2015 with a cultivator. The sowing was performed manually on 22<sup>nd</sup> of April 2015 and the plant density was of 70,000 plants.ha<sup>-1</sup> for all the 45 experimental variants. The fertilization was performed with 80 kg.ha<sup>-1</sup> of nitrogen and 40 kg.ha<sup>-1</sup> of phosphorus. The weed control was performed by the help of herbicide (Dual Gold 960 EC based on the active substance S-metolaclo 960 g/l) applied at a dose of 1.2 l.ha<sup>-1</sup> one day after sowing (on 23<sup>rd</sup> of April, 2015). The herbicide weed control was completed by one manual hoeing performed on 26<sup>th</sup> of May 2015.

Determinations of fresh and dry biomass were performed in the early dough - dough plant growth stage, respectively in the growth stage when the sunflower biomass is of importance to be used as substrate for biogas production. For each experimental variant the sunflower plants from one square meter were cut at soil level and were weighed immediately for determining the fresh biomass yield (as above-ground biomass). One sunflower plant for each variant was taken into the laboratory and dried in the oven at 80°C for 24 hours in view to be determined the dry biomass yield. The biomass to which we are referring in this paper represents the above-ground biomass.

## RESULTS AND DISCUSSIONS

Among the three studied preceding crops, the highest biomass yields as average values were obtained when sunflower followed after maize with ploughing as soil tillage, respectively 33.46 tons.ha<sup>-1</sup> of fresh biomass and 8.72 tons.ha<sup>-1</sup> of dry biomass (Figure 1). When the preceding crop was maize but with harrowing as soil tillage (without ploughing) the biomass yield decreased compared to the variant with ploughing as soil tillage, but the decrease was less important for fresh biomass (33.24 tons.ha<sup>-1</sup>) and more important for dry biomass (8.28 tons.ha<sup>-1</sup>). The smallest biomass yields were obtained after triticale with harrowing as soil tillage, respectively 32.12 tons.ha<sup>-1</sup> of fresh biomass and 7.91 tons.ha<sup>-1</sup> of dry biomass.

Despite the fact that maize as preceding crop with ploughing as soil tillage determined the largest variation of fresh biomass yields, the dry biomass yields registered less variations and the highest values (Figure 1).

Regarding the biomass yields obtained at different row spacing conditions, the average values of the biomass yields were not significant different (Figure 2). The differences among the average values were more visible for fresh biomass than for dry biomass. It is interesting to point out that narrow rows determined higher yields of fresh biomass compared to row spacing of 70 cm, but with larger variations of the values. Concerning the dry biomass, the yields registered the highest values at wider rows, respectively at row spacing of 70 cm (8.36 tons.ha<sup>-1</sup>). Taking into account the fact that the results were obtained in a year characterized as being warmer and drier than normal years for the studying area, these results are confirming partly the previous results we have obtained in the area where the field experiment was performed, respectively when growing conditions are less favourable, the yields of fresh and dry biomass tend to be higher at narrow rows (Ion et al., 2014; Ion et al., 2015).

Despite the fact that the row spacing of 70 cm determined the smallest average value for the fresh biomass (32.44 tons.ha<sup>-1</sup>), however it determined the highest value for the dry biomass (8.36 tons.ha<sup>-1</sup>). Also, despite the fact that the row spacing of 70 cm determined the

smallest variation for the fresh biomass yield, it determined the largest variations for the dry biomass yield (Figure 2).

It is interesting to underline that the dry biomass obtained at row spacing of 50 cm (8.28 tons.ha<sup>-1</sup>), which is quite closed to that obtained at row spacing of 70 cm (8.36 tons.ha<sup>-1</sup>), it registered the smallest variations and the highest minimum values, this being quite stable, (Figure 2).

The twin-rows of 70/40 cm determined the highest average value for the fresh biomass yield (33.53 tons.ha<sup>-1</sup>) but, however the smallest average value for the dry biomass yield (8.25 tons.ha<sup>-1</sup>).

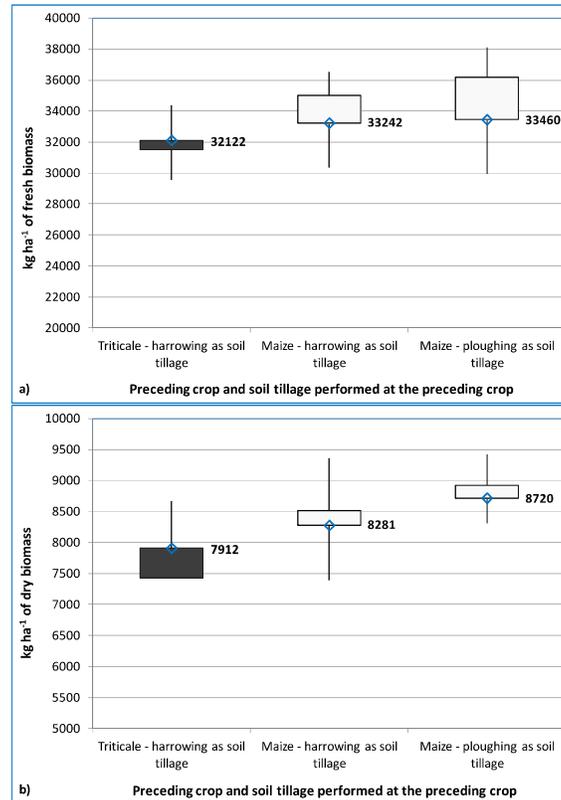


Figure 1. The fresh (a) and dry (b) biomass yields obtained at sunflower after different preceding crop conditions (Moara Domnească location, 2015)

As it was expected, there are important variations regarding the fresh and dry biomass yields according to hybrid, function of the hybrid characteristics (Figure 3). This is confirming the idea that the hybrid has to be chosen also according to the crop destination, respectively for biomass purposes has to be chosen a hybrid with a high potential to produce biomass among other characteristic.

In the year 2015, which was affected by drought, and for the studied conditions, the average dry biomass yields were less than 10 tons.ha<sup>-1</sup>, while in the same area but under better climatic condition the average dry biomass yields were between 13 and 18 tons.ha<sup>-1</sup> (Ion et al., 2014; Ion et al., 2015).

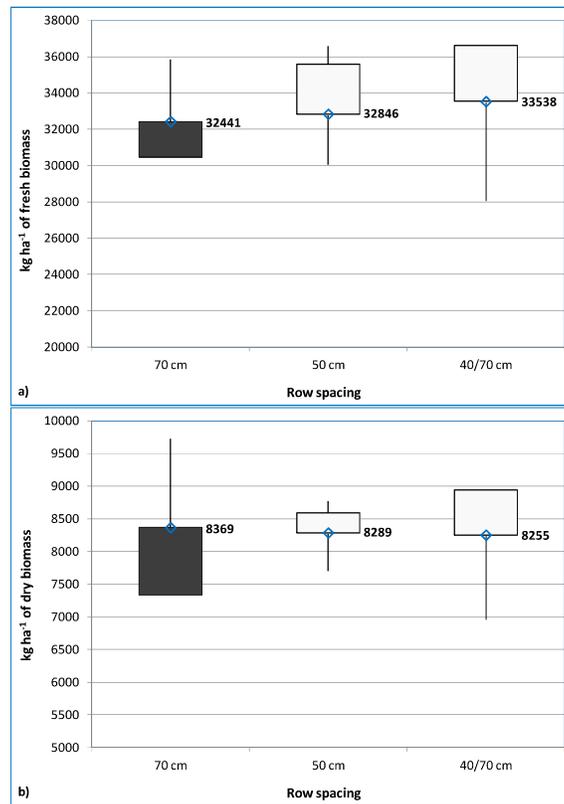


Figure 2. The fresh (a) and dry (b) biomass yields obtained at sunflower at different row spacing conditions (Moara Domneasă location, 2015)

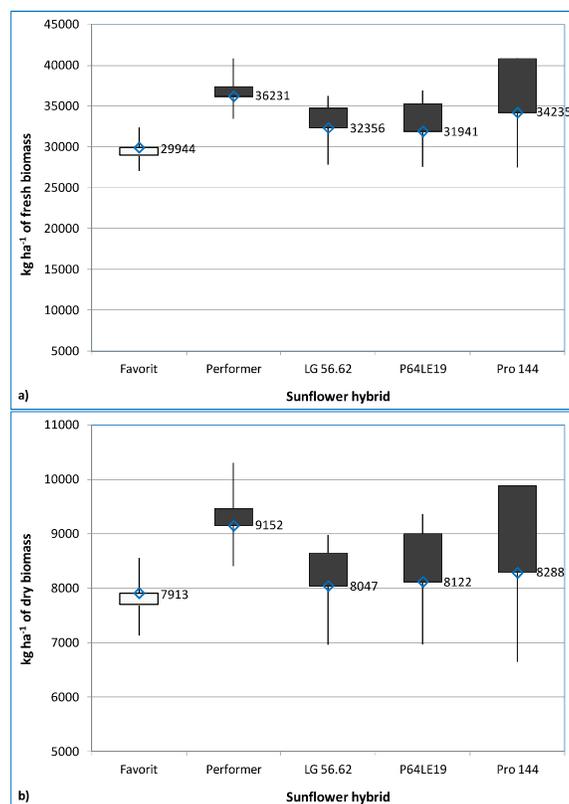


Figure 3. The fresh (a) and dry (b) biomass yields obtained at different sunflower hybrids (Moara Domneasă location, 2015)

## CONCLUSIONS

For biomass purposes, the grower has to choose a sunflower hybrid with a high potential to produce biomass among other characteristic, but also he has to use a proper crop technology. Thus, for producing biomass at sunflower crop and for the studied conditions, in a year affected by drought, maize was a better preceding crop compared to triticale, especially when maize had the ploughing as soil tillage. The different row spacing conditions determined dry biomass yields quite closed, but with a larger variation at 70 cm between rows and a smaller variation at 50 cm between rows.

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