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SUNFLOWER BIOMASS YIELD AT DIFFERENT ROW SPACING AND NITROGEN FERTILISATION CONDITIONS

Adrian Gheorghe BĂȘA[1], Viorel ION[1], Marin DUMBRAVĂ[1], Lenuța Iuliana EPURE[1], Nicoleta ION[2]

[1]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd, District 1, 011464, Bucharest, Romania
[2]Apiculture Research and Development Institute of Bucharest, 42 Ficusului Blvd, District 1, 013975, Bucharest, Romania

Corresponding author email: adibasa@agro-bucuresti.ro

Abstract

Sunflower is one of the most important crops in Romania, being cultivated on about one million hectares in the last years. Apart producing the seeds for oil production, sunflower is also one of the most important melliferous plants, providing important quantities of honey. But, in addition to the above mentioned consecrated uses, sunflower crop could be an important source of biomass, which can be used as raw material for biogas production. From this perspective, the aim of this study was to evaluate the influence of the row spacing and the nitrogen fertilisation conditions on the biomass yield at the sunflower crop. For accomplishing this aim, a field experiment was performed in 2016 in the specific growing conditions from South Romania (44°29' N latitude and 26°15' E longitude), respectively at Moara Domnească Experimental Farm belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest. Four sunflower hybrids (Performer, Pro 144, P64LE19, and LG56.62) were studied at two row spacing (50 cm and 70 cm) and four nitrogen fertilisation conditions (0 kg.ha^{-1}, 50 kg.ha^{-1}, 100 kg.ha^{-1}, and 50 + 50 kg.ha^{-1}). The biomass determinations were performed in the early dough - dough plant growth stage. The obtained results showed that in the more favorable growing conditions represented by a better nitrogen supply through a nitrogen rate of 100 kg.ha^{-1} whether that was administrated in one application or in two applications of 50 kg.ha^{-1}, the dry biomass yields were higher at wide row spacing (70 cm between rows) then at narrow row spacing (50 cm). In the contrary, in less favorable growing conditions represented by no nitrogen application and nitrogen rate of 50 kg.ha^{-1}, the dry biomass yields were higher at narrow row spacing (50 cm between rows) then at wide row spacing (70 cm between rows).

Key words: *sunflower, dry biomass yield, row spacing, nitrogen fertilisation.*

INTRODUCTION

Sunflower is one of the most important crops in Romania, being cultivated on about one million hectares in the last years and ranking the third place as cultivated surface. Apart producing the seeds for oil production, sunflower is also one of the most important melliferous plants, providing important quantities of honey and being considered the most important melliferous crop. But, in addition to the above mentioned consecrated uses, sunflower crop could be an important source of biomass, which can be used as raw material for biogas production. From this perspective, the aim of this study was to evaluate the influence of the row spacing and the nitrogen fertilisation conditions on the biomass yield at the sunflower crop.

Growing biomass is among the cheapest options for CO_2 emissions reduction, particularly if that biomass is used for energy production (Roman et al., 1998).

Energy crops for biogas production need to be grown in sustainable crop rotations (Amon et al., 2007; Hahn and Ganssmann, 2008). Sunflower (*Helianthus annuus* L.) can be part of the energy crop rotations, respectively it can be included into the structure of the energy crops that could be used for biomass production (Dicu et al., 2016).

Sunflower could be characterised as being a crop tolerating the drought and succeeding under limited input conditions (Ion et al., 2015). In fact, sunflower is a temperate zone crop, which can perform well under a variety of climatic and soil conditions (Canavar et al., 2010). Moreover, sunflower fits well into various cropping systems (Pattanayak et al., 2016).

One of the important conditions to produce biomass in an efficient way is to use the most appropriate cultivation techniques (Balodis et al., 2011; Beg et al., 2007). In fact, studying the effect of different technological conditions, such as row spacing and nitrogen fertilisation, on the potential biomass yield that could be obtained at sunflower crop is of interest and importance for farmers growing sunflower for biomass production. But, research is needed to determine the best agricultural practices, which are targeted at maximizing yield in the field (biomass/hectare) (Ziebell et al., 2013).

MATERIALS AND METHODS

Researches were performed in the year 2016, under rainfed conditions, in a field experiment located in South Romania, respectively within Moara Domnească Experimental Farm (44°29' N latitude and 26°15' E longitude), belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest.

The year 2016 can be characterised from a climatic point of view as being warmer and drier than normal years defined by the average multiannual values of the climatic elements. Thus, in the period April-August, the average temperature was of 20.1°C, while the multiannual value is of 18.5°C, and the sum of rainfall was of 284 mm, while the multiannual value is of 313.2 mm.

The soil from the experimental area is a reddish preluvosoil, with is characterised by a humus content of 2.2 - 2.8%, clay loam texture, and pH values of 6.2 - 6.6.

The field experiment consisted in sowing four sunflower hybrids (Performer, Pro 144, P64LE19, and LG56.62) at two row spacing (50 cm and 70 cm) and four nitrogen fertilisation conditions (0 $kg.ha^{-1}$, 50 $kg.ha^{-1}$, 100 $kg.ha^{-1}$, and 50 + 50 $kg.ha^{-1}$.

Nitrogen fertilisation was performed with ammonium nitrite (33.5% nitrogen content), which was applied immediately after sowing, on 1st of April 2016, except for the experimental variant N_{50+50} that consisted in applying half of nitrogen rate (50 $kg.ha^{-1}$) just after sowing and the other half in the growth stage of six leaves (BBCH code 16), on 27th of May 2016.

The field experiment was organised in split plots with 32 experimental variants (4 hybrids x 2 row spacing x 4 nitrogen fertilisations). Each experimental variant consisted in six lines with a length of 8 m.

The crop technology consisted in the followings:

- the preceding crop was maize;
- ploughing was performed on 30th of October 2015;
- one harrow work was performed on 18th of March 2016, this being followed by one combinator work performed on 28th of March 2016;
- sowing was performed by the help of a manual planter on 1st of April 2016;
- plant density was of 60,000 $plants.ha^{-1}$;
- the weed control was performed by two manual hoeing.

For each experimental variant, the sunflower plants from one square meter were cut at soil level and they were weighed immediately in the field in view to be determined the fresh biomass yield expressed as above-ground biomass. One average sunflower plant for each experimental variant was taken into the laboratory where it was cut in small pieces and then dried in the oven at 80°C for 24 hours in view to be determined the dry biomass yield.

The biomass determinations were performed in the early dough - dough plant growth stage taking into account that in the growth stage the sunflower biomass is of importance as raw material for biogas production. The obtained data were statistically processed using the analysis of variance (ANOVA).

RESULTS AND DISCUSSIONS

Application of nitrogen and increasing the nitrogen rate from 50 to 100 $kg.ha^{-1}$ increased the dry biomass yield of sunflower, with differences statistically significant for the nitrogen rate of 50 $kg.ha^{-1}$ and distinct significant for the nitrogen rate of 100 $kg.ha^{-1}$ (Table 1).

Compared to the dry biomass yield obtained at the nitrogen rate of 100 $kg.ha^{-1}$, respectively 11.05 $tons.ha^{-1}$, the dry biomass yield obtained in the conditions of splitting the nitrogen rate of 100 kg.ha^{-1} in two applications of 50 kg.ha^{-1} was smaller, respectively 10.59 tons.ha^{-1}, but still with a difference statistically distinct significant compared to control variant, respectively the variant with no nitrogen application (Table 1). This situation was registered for the row spacing of 70 cm as well as for the row spacing of 50 cm (Table 2). The highest dry biomass yields were registered at row spacing of 70 cm and the nitrogen rate of 100 kg.ha^{-1} whether the nitrogen was administrated in one application or in two applications of 50 kg.ha^{-1}, the differences being very significant compared to control variant.

Table 1. The dry biomass yields obtained at sunflower in different nitrogen fertilization conditions

Nitrogen rate (kg.ha^{-1})	Dry biomass			
	Yield (tons.ha^{-1})	Difference		
		Kg.ha^{-1}	%	Significance
0	8.63	0	100	control
50	10.00	1.37	115.87	*
100	11.05	2.42	128.04	**
50 + 50	10.59	1.96	122.71	**

5% LSD 1.13 tons.ha^{-1}
1% LSD 1.65 tons.ha^{-1}
0.1 % LSD 2.47 tons.ha^{-1}

Table 2. The dry biomass yields obtained at sunflower in different row spacing and nitrogen fertilization conditions

Row spacing (cm)	Nitrogen rate (kg.ha^{-1})	Dry biomass yield (kg.ha^{-1})	Difference		
			kg.ha^{-1}	%	Significance
70	0	8.05	0	100	control
	50	9.70	1.65	120.50	*
	100	11.69	3.64	145.22	***
	50 + 50	11.02	2.97	136.89	***
50	0	9.21	1.16	114.41	
	50	10.30	2.25	127.95	**
	100	10.41	2.36	129.32	**
	50 + 50	10.16	2.11	126.21	**

5% LSD 1.39 kg.ha^{-1}
1% LSD 1.92 kg.ha^{-1}
0.1 % LSD 2.64 kg.ha^{-1}

The dry biomass yields were higher at the row spacing of 50 cm for control variant (the variant with no nitrogen application) and the variant with the nitrogen rate of 50 kg.ha^{-1}, while for the row spacing of 70 cm the dry biomass yields were higher for the variants with the nitrogen rate of 100 kg.ha^{-1}, whether that was administrated in one application or in two applications of 50 kg.ha^{-1} (Figure 1). These findings are according to those already reported by Ion et al. (2015) for the studied area, respectively for favourable growing conditions the dry biomass yield tends to be higher at wide row spacing (75 cm between rows), while for less favourable growing conditions the dry biomass yield tends to be higher at narrow rows (row spacing of 50 cm). In our case, favourable growing conditions means a better nitrogen supply by a nitrogen rate of 100 kg.ha^{-1} whether that was administrated in one application or in two applications of 50 kg.ha^{-1}, and less favourable growing conditions means no nitrogen application and a nitrogen rate of 50 kg.ha^{-1}. However, the average dry biomass yields obtained in the conditions of the two row spacing were quite close.

The sunflower biomass moisture content varied between 71 and 76%, according to the row spacing and nitrogen fertilization conditions (Figure 2).

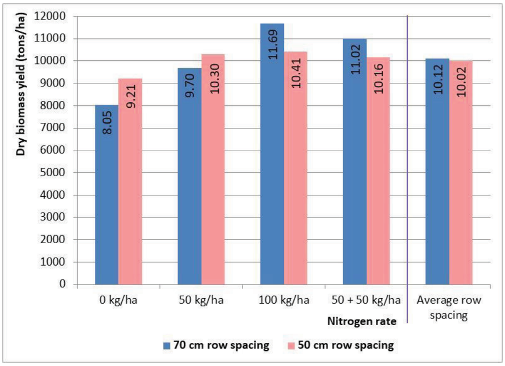

Figure 1. The dry biomass yields obtained at sunflower in different row spacing and nitrogen fertilization conditions

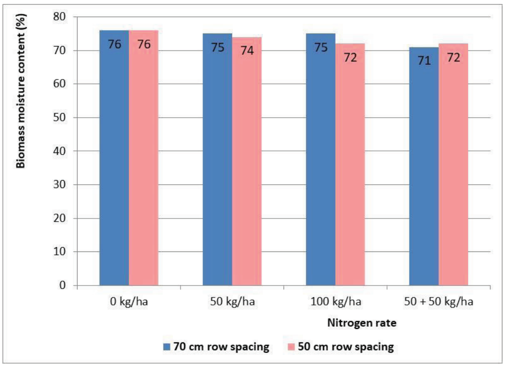

Figure 2. The sunflower biomass moisture content in different row spacing and nitrogen fertilization conditions

It has to be pointed out that the dry biomass yields obtained at sunflower in the climatic conditions of 2016 are smaller for the studied area, this year being characterised by higher temperatures and less rainfall compared to multiannual average values.

CONCLUSIONS

For the specific growing conditions, respectively on a reddish preluvosoil and in the climatic conditions of the year 2016 in South Romania, nitrogen fertilisation and increasing the nitrogen rate from 50 to 100 $kg.ha^{-1}$ increased the dry biomass yield of sunflower, with differences statistically significant for the nitrogen rate of 50 $kg.ha^{-1}$ and distinct significant for the nitrogen rate of 100 $kg.ha^{-1}$.

The obtained results showed that in the more favorable growing conditions represented by a better nitrogen supply through a nitrogen rate of 100 $kg.ha^{-1}$ whether that was administrated in one application or in two applications of 50 $kg.ha^{-1}$, the dry biomass yields were higher at wide row spacing (70 cm between rows) then at narrow row spacing (50 cm). In the contrary, in less favorable growing conditions represented by no nitrogen application and nitrogen rate of 50 $kg.ha^{-1}$, the dry biomass yields were higher at narrow row spacing (50 cm between rows) then at wide row spacing (70 cm between rows).

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