XXVI INTERNATIONAL ECO-CONFERENCE® 2022
21–23th SEPTEMBER

XII SAFE FOOD

ЕКОЛОШКИ ПОКРЕТ НОВОГ САДА

PROCEEDINGS

NOVI SAD, SERBIA

XXVI INTERNATIONAL ECO-CONFERENCE® 2022
XII SAFE FOOD
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Original Scientific paper

INFLUENCE OF GENOTYPES AND DIGESTATE ON THE PRODUCTIVITY OF THE MORPHOLOGICAL INDICATOR OF SILAGE-SORGHUM AS HIGH QUALITY FEED

Abstract

Fodder sorghum is used for preparing silage in the phase of milk-wax maturity, when sorghum contains 65-70% water. Sorghum silage is mostly used in the diet of dairy cows. Since sorghum contains a lot of sugar, silage is successfully prepared without the addition of additives. Sorghum forms a large biomass during the year. After each mowing the plants regenerate giving a new swath. The aim of this study is to examine the influence of digestate on sorghum productivity in the conditions of Vojvodina. Digestate had a great influence on plant productivity. Based on the analysis of variance, it is evident that there is a significant difference in the number of leaves per plant in relation to the variant (Fekp = 7.118 *)

Key words: *fodder sorghum, fodder, number of leaves / plants, chemical traits*

INTRODUCTION

Fodder sorghum is an annual crop from the group of cereals, which is grown in Serbia on about 2000 ha. It belongs to the order *Poales*, family *Poaceae*, subfamily *Panicoideae*, genus *Sorghum* which contains 34 plant species. Fodder sorghum is characterized by high yields and high biomass production in our agro-ecological conditions. Most of these species are annual or perennial wild plant species, often weeds in the fields. The most interesting for cultivation are two annual species and two interspecies hybrids: *Sorghum bicolor* (L.) Moench. – common sorghum, *Sorghum sudanense* L. – Sudanese grass, *Sorghum almum* Parodi – perennial almum sorghum and *Sorghum bicolor x S. sudanense* – interspecies hybrid of common sorghum and Sudanese grasses (Lakić et al., 2018). It is characterized by high yields and high biomass production in our agro-ecological conditions. Green biomass yields range from 50 to 70 tha^{-1}. It is resistant to drought, diseases and pests. In times of drought, it can stop development without harmful consequences, and as soon as moisture is provided, it continues to develop unhindered. The first swath for green mass, which gives the largest amount of green mass, arrives 50 days after germination, and the next one in 40 days. The yield of green biomass is from 50 to 70 tha^{-1}, and even 100 tons. For the preparation of silage, sorghum is used in the phase of milk-wax maturity, when sorghum contains 65-70% water. Sorghum contains enough sugar, so silage is successfully prepared without the addition of additives. Sorghum silage is mostly used in the diet of dairy cows. Sorghum can also be used successfully as an energy crop.

The primary task of breeding is to create new inbred lines in order to obtain high-yielding and stable hybrids of good quality (Berenji, 1990). The goal of the selection is to create two types of sorghum hybrids: hybrids for animal feed and energy hybrids. The results of the analysis of yield and yield components in lines and hybrids are indicators used in selection and correctly direct the selection process towards obtaining hybrids of desirable quality, but also give a clear picture of the mode of inheritance (Debnath & Sarker 1989). Bangarwa et al. (1989) emphasize that selection for dry matter should be based on plant height and number of broad leaves, and it is necessary to pay attention to odder quality, because yield and quality determine the value of the genus Sorghum in ruminant nutrition. Domestic sorghum hybrids are mostly used for sowing in our country, but also hybrids of foreign seed houses. The Domestic Seed House Institute of Field and Vegetable Crops, has three varieties of fodder sorghum: Siloking, Titan and NS Džin with a biomass yield of over 100 t/ha in dry farming conditions (Glamočlija et al., 2015).

NS Džin is a new variety of fodder-sorghum created by crossing the lines of fodder sorghum and Sudanese grass. It is a multi-mowing variety (up to three mowing), with a high genetic potential for forage yield, over 100 tha^{-1} in dry farming conditions. It is mowing when the plants are 1.0-1.5 m tall. It is characterized by fast initial growth, excellent tillering and good regeneration after mowing. Siloking is a medium-late hybrid of sugar sorghum, long vegetation and high yields of green fodder and silage, suitable for late mowing and ensiling. It is resistant to economically significant diseases. The stem remains juicy until the end of vegetation, and is an excellent raw material for making silage in bio-digesters for biogas production. It achieves very high biomass yields, up to 110 t/ha. The domestic genotype Siloking has a fat content of 2.48%, a raw ash content of 11.60%, a cellulose content of 32.79% and BEM, and a dry matter content of 41.27% (Pataki et al., 2010). Titan is a new multi-mowing variety of fodder-sorghum, created by crossing the lines of fodder-sorghum and Sudan grass. The variety gives up to 3 mowing, high genetic potential for forage yield. In the conditions of dry farming, it produces up to 80 tha^{-1} green fodder. This variety regenerates well after mowing, has a fast initial growth and excellent tillering. Thanks to the deep threadlike root of strong suction power, fodder sorghum can be successfully grown on different types of soil (salt marshes, sandy and heavier soils), which are less suitable for other plant species. Fodder sorghum tolerates drought and high temperatures well. The value of fodder sorghum will be even more significant if genotypes are found that will surpass silage corn in quality and yield. After mowing, sorghum regenerates from the ground nodes, so it can give a higher yield and better quality from two mowing, because the plants are used in the younger stages. It tolerates drought well, because it has a developed root system with strong suction power, and it uses water and nutrients from the soil, which are inaccessible or difficult to access for other cultivated crops. In the selection of parent lines for creating hybrids, those that have a succulent stem by the end of the vegetation are selected, and the seeds ripen on a green and succulent stem (Pataki et al., 2010).

We are witnesses of more frequent droughts and high daily temperatures (Popović et al., 2020a, 2020b). In such conditions, by sowing fodder sorghum, a high biomass yield is achieved, thus the possibility of obtaining the use of raw materials for biofuel. Due to the great importance of sorghum and its application, the aim of the study was to examine two energy hybrids in Vojvodina and the possibility of obtaining biogas and methane yields from sorghum biomass and to determine the impact of digestate, bio-stimulant nutrients on plant highness, number of leaves, sorghum biomass and biogas yield.

MATERIALS AND METHODS

During 2021, experiment was set up as randomized block system in 12 repetitions with the size of basic plots of 10 m^2 (5 m x 2 m) in two variants, at the Ilandža site, on hydrogen-type marsh black soil. Standard cultivation technology for sorghum to obtain silage was used. For germination and sprouting of seeds, a minimum temperature of 8-10 °C is required, which is why sowing was done in the optimal time, at the end of April. Experiments with two genotypes G1-Bulldozer (KWS) and G2-Siloking (Institute of Field and Vegetable Crops, Novi Sad), were set up, in two variants: without digestate – control (C) and variant with digestate, which was introduced into the soil immediately before sowing sorghum – digestate (ADD). In both variants, 115 $kgNha^{-1}$ (250 kg / ha UREA with 46% N) was applied to the soil. Fodder sorghum hybrids, Bulldozer and Siloking were sown using a seeder for wide crops, at an optimal depth of 3 cm, density 30 kg of seeds ha^{-1} (250,000 plants per ha), after quality pre-sowing soil preparations. Mowing of plants was performed at the beginning of the broom phase (second decade of July), for the analysis of morphological characteristics of the number of leaves, samples were taken from freshly mowed biomass. The results were analyzed by the method of analysis of variance of one-factor testing (ANOVA) using the statistical Program STATISTICS 12 and presented in tables and graphs. Significance of differences in mean treatment values was tested by LSD test.

RESULTS AND DISCUSSION

Meteorological conditions during the sorghum vegetation period

Depending on the climatic conditions, the variety has different plant production (Popovic et al., 2020a. Ikanović et al. 2013, 2020a, 2020b). Weather conditions for Ilandža were taken from the meteorological station in Vršac (Figures 1a and 1b).The average perennial temperatures, for the sorghum vegetation period, for Ilandža were 20.1 °C and the total vegetation precipitation was 209.2 mm. The vegetation season in 2021 is characterized by a higher amount of precipitation (334.4 mm) by 44.2 mm and lower average monthly air temperatures (18.9 °C) compared to the multi-year average for the Ilandža area (Fig. 1a and 1b).

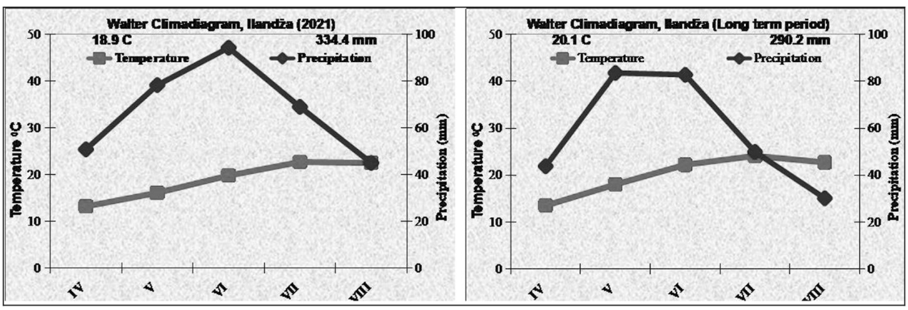


Figure 1. Mean monthly air temperatures (°C) and precipitation (mm) for the sorghum growing season in 2021, a)., long term period b)

Morphological parameter: Number of fodder sorghum leaves per plant

The examined morphological-productive trait of sorghum genotypes is shown in Tables 1 and 2. Based on the analysis of variance, it is evident that there is a significant difference in the number of leaves per plant in relation to the variant (F_{ekp} = 7.118 *), (Table 1). Genotype and interaction of examined factors (V × G) did not have a significant effect on the height of the obtained value of the number of leaves per plant ($p > 0.05$).

Table 1. ANOVA for number of leaves

Parameter	SS	Degr. of Freedom	MS	F	p
Intercept-blocks	2268.750	1	2268.750	1601.471	0.000000
Genotype – G	6.750	1	6.750	4.765^{ns}	0.060595
Variant – V	10.083	1	10.083	7.118*	0.028455
Genotype×Variant	0.083	1	0.083	0.059^{ns}	0.814467
Eror	11.333	8	1.417		

The average value of the number of leaves of genotype G1 fodder sorghum varied from 13.66 in the control variant to 15.33 in the variant with digestate, while the average value in genotype G2 varied from 12.00 in the control variant to 14.00 in the variant with digestate. The average value for the number of leaves per plant for genotype G1 was 14.50, while genotype G2 had 13.00 leaves per plant. There were no statistically significant differences between the examined genotypes for the values of the number of leaves per plant, Table 2, graphs 3 and 4.

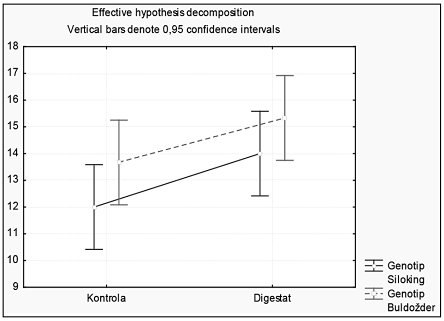
Table 2. Average values of examined morphological-productive parameters of fodder sorghum

Genotype	Year	Variant	Number of leaf
G1-Buldoždер	2021	Control	13.66±0.57
		Digestate	15.33±0.58
Average			14.50±1.05
IV			1.67
Std. Error			0.43
G2-Siloking	2021	Control	12.00±2.00
		Digestate	14.00±1.01
Average			13.00±1.79
IV			2.00
Std. Error			0.73
Total Average			13.75±1.61
IV			1.50
Std. Error			1.60

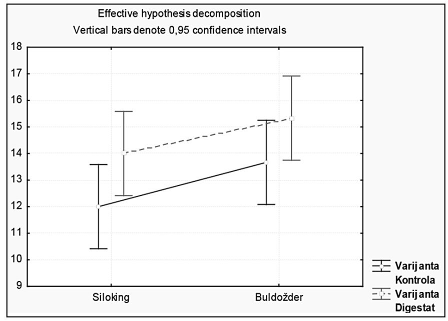
Parameter	**Genotype**		**Variant**		**G x V**	
LSD	**0.5**	**0.1**	**0.5**	**0.1**	**0.5**	**0.1**
Number of leaf	1.585	2.306	1.584	2.305	2.703	3.261

Field trials should enable the selection of the most successful genotypes, which is critical due to the existence of genotype interaction with the environment. To assess this interaction, we are forced to conduct field research in several settings and / or years (Popović et al., 2011; 2013; 2019; Bojović et al., 2019; Lakić et al., 2018; 2019; 2020; Rakaščan et al., 2019; 2020; Mladenović-Glamočlija et al., 2020).

Fodder sorghum hybrids achieve high yields of green mass and dry matter and represent very high quality animal feed. In recent times, fodder sorghum is also used as a raw material for biogas production. In the area of eastern Croatia, in different agro-ecological conditions, fodder sorghum hybrids achieved a dry matter yield of 9.4 to 28.0 tha^{-1} (Gantner et al., 2015).



a.



b.

Graph. 3. Interaction V x G a.) and interaction G x V (b.) for number of leaves per plant of fodder sorghum

The nutritional composition of the fresh forage samples is in table 3. Forage sorghum (https://dellait.com/nutritional-composition-of-sorghum-silage/) had DM 28.1, starch 17.2%, protein content 5.0% and fat 2.0% prior to ensiling.

Table 3. Nutritional composition of Forage sorghum

No.	Parameter	Forage sorghum
1.	Dry matter (% AF)	28.1
2.	Protein (% DM)	5.0
3.	Neutral detergent fiber (% DM)	55.1
4.	Starch (% DM)	17.2
5.	Non-fibrous carbohydrates (% DM)	34.6
6.	Fat (% DM)	2.0

Neutral detergent fiber was 55.1% in Forage sorghum. Sorghum silage is high in water-soluble carbohydrates, which promote the growth of lactic acid bacteria, responsible for lowering the pH. In addition, sorghum silage has little buffering capacity (Fernandes et al., 2020), so pH reduction is often rapid in the early stages of the conservation process.

Mowed biomass can be stored as haylage, silage or dried. Fresh sorghum biomass can be used for domestic animals, after wizen for several hours to decompose harmful substances. Over 70 t ha^{-1} of fresh sorghum biomass can be obtained during the year (Lakić et al., 2018).

CONCLUSION

The use of digestate on the soil has led to an increase in the number of leaves per plant. The obtained results showed a strong positive effect of digestate on the number of leaves per sorghum plant, while there was no statistically significant difference between the examined genotypes for the examined parameter. Future research on the morphological characteristics of sorghum is needed, as well as the use of more hybrids to determine which are the most productive and economical to produce.

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UTICAJ GENOTIPA I DIGESTATA NA PRODUKTIVNOST MORFOLOŠKOG POKAZATELJA SILAŽNOG SIRKA KAO VISOKOKVALITETNE STOČNE HRANE

Izvod

Krmni sirak se koristi za spremanje silaže u fazi mlečno-voštane zrelosti, kada sirak sadrži 65-70% vode. Silaža od sirka najviše se koristi u ishrani mlečnih krava. Pošto sirak sadrži dosta šećera, silaža se uspešno sprema bez dodavanja aditiva. Sirak formira veliku biomasu tokom godine, posle svake kosidbe biljke se regenerišu dajući novi otkos. Cilj ove studije je da se ispita uticaj digestata na produktivnost sirka u uslovima Vojvodine. Digestat je imao veliki uticaj na produktivnost biljaka. Pokošena biomasa može se spremati kao senaža, sinaža ili se suši. Sveža biomasa sirka za ishranu domaćih životinja može se koristiti kad provene nekoliko sati da bi se razložile štetne supstance. Tokom godine može se dobiti preko 70 t ha^{-1} sveže biomase sirka.

Ključne reči: *krmni sirak, stočna hrana, broj listova/biljci, intreakcija godina genotip*

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