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Contents

PRODUCTIVITY BIOMASS AGRO-ENERGY CROPS – SORGHUMS – TOLERANTS BY ENVIRONMENTAL CONDITIONS

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Abstract
Sorghum as a crop species has specific physiological predisposition for tolerance to unfavorable environmental conditions and has the ability to convert solar energy into biomass with high efficiency. The average mass of stem was 175.16 g. Genotype Dale had lower mass of stem compared to genotype NS sweet corn. Average panicle length was 18.20 cm. Genotype Dale had a longer panicle compared to the genotype NS sweet corn. The difference in length panicle between the genotypes NS corn sweet and Dala was not statistically significant. There is an evident correlation between the components of morphological characteristics: mass of stem, panicle length and environmental conditions. Mass stem was positively correlated with the panicle length and the temperature and the poor negative correlation with precipitation.

Keywords: Genotypes, Sorghum, climatic factor, correlation, morphological characteristics

Introduction

Biomass energy production is a very wide term which, among alia encompasses all forms of organic matter such as wood, organic matter herbaceous plants, agricultural crops, agricultural residues, aquatic vegetation, animal fertilizers, and communal solid waste. There are lot of plants that have the ability to convert solar energy into biomass with high efficiency, including herbaceous crops, fast-growing woody crops, fodder crops (alfalfa, clover, canary grass and Miscanthus), sugar crops (sugar cane, sugar beet, fibrous and sweet sorghum), cereals (corn, barley and wheat), and oilseed crops (soybean, rapeseed, palm, sunflower, safflower, canola and cotton) to allegations Lewandowski (2000) and Kresovic et al. (2016).

According to botanical classification of summary named Sorghums means the more plant species belonging to the genus Sorghum (Clayton & Renvoize 1986). One of these species is *S. bicolor*, which author de Wet (1978) includes annual and perennial cultivated and wild forms. According to modern classification, all sorghum grown in our area belong to the plant species *S. bicolor*. Per agronomic classification based on the method of cultivation and the use of *S. bicolor* is divided into so-called agronomic forms: grain sorghum, sorghum broomcorn, sorghum, sweet corn and Sudan grass (Sikora, Berenji, 2010a, 2010b, Sikora et al. 2012, 2013, 2014, 2015).

Sorghum as a crop of tropical origin has specific physiological predisposition for tolerance to unfavorable environmental conditions. The genetic potential for grain sorghum yield is still significantly limited due to the influence of abiotic stress. Stress caused by lack of moisture is the most important abiotic influence coma plants can be exposed throughout the growing season. At sorghum is observed and described several physiological factors of drought tolerance (Sikora et al., 2013, 2014). The term stress was performed from the Latin word stringers, which meaning limiting force. From the aspect of plant production, Grime (1979) defines stress as an external constraint that limits the level of dry matter production during the whole or part of the vegetation

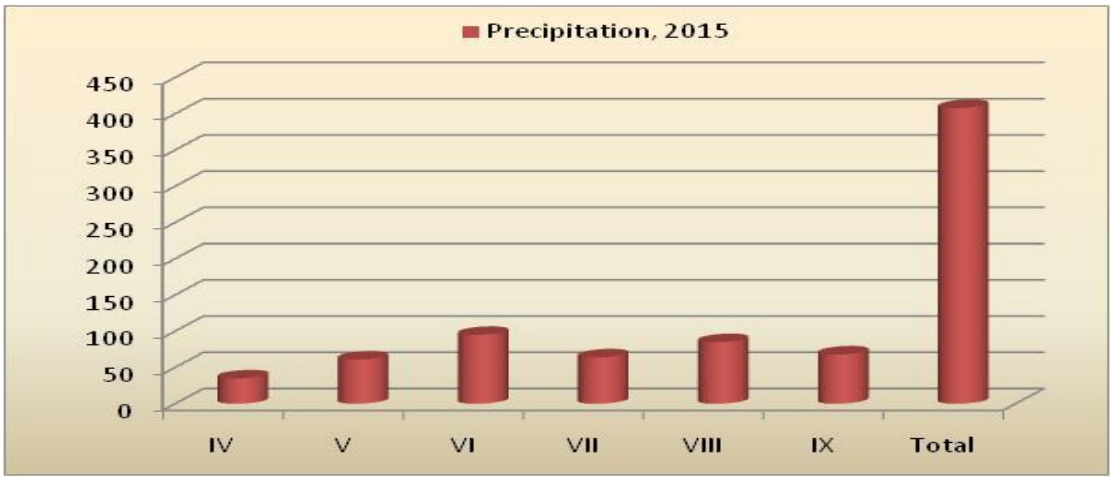
under genetic potential. Jones and Jones (1989) as the response of plants to stress in the definition of the term production of dry matter replaced by the term economic yield.
Contemporary humankind over the past twenty years, faced with growing problems of global warming. Approval of the Kyoto Protocol in Japan (1997), are set targets for the reduction of greenhouse effect gas emissions at the international level. On 21 conference on climate change held in Paris, adopted a new global agreement. On imperative to reduce greenhouse effect gas emissions, and allowable temperature the growth to 1.5 ° C, starting from 2020 with the entry into the power, committed themselves 196 Member States, including the Republic of Serbia. The obligation of our country is that by 2030 reduce emissions by 9.8% compared to 1990.
One of the main causes of drought, which manifests itself as an insufficient amount of water in the soil to meet the needs of plants for normal growth and development, is the lack of the total amount of rainfall during the year and their distribution during the vegetation period of the plants and the intensity of atmospheric evaporation precipitates (Maksimovic et al., 2016). Monitoring and analysis of weather and climate conditions are essential for the analysis of the achieved yield and the quality obtained (Popović, 2010, Maksimovic et al., 2016,). On the ability to retain water in the soil also affects a series of agricultural measures: the choice of previous crop and cultivated species of a certain genotype, sowing date, circuit, fertilization, inter-row cultivation, irrigation and use of the preparation for the conservation of water (Maksimovic et al. 2016).
Due to the extremely high variability of the genus Sorghum is possible to create a hybrid for specific purposes, such as the high sugar content in the stem, and plants with high cellulose content are suitable for the production of bio-energy (renewable energy). With the intensification of agricultural production, part of the arable land is justified used to produce bioenergy (Pataki, 2012). The aim of this study was to determine the productivity of biomass sorghum on chernozem soil.

Material and Methods

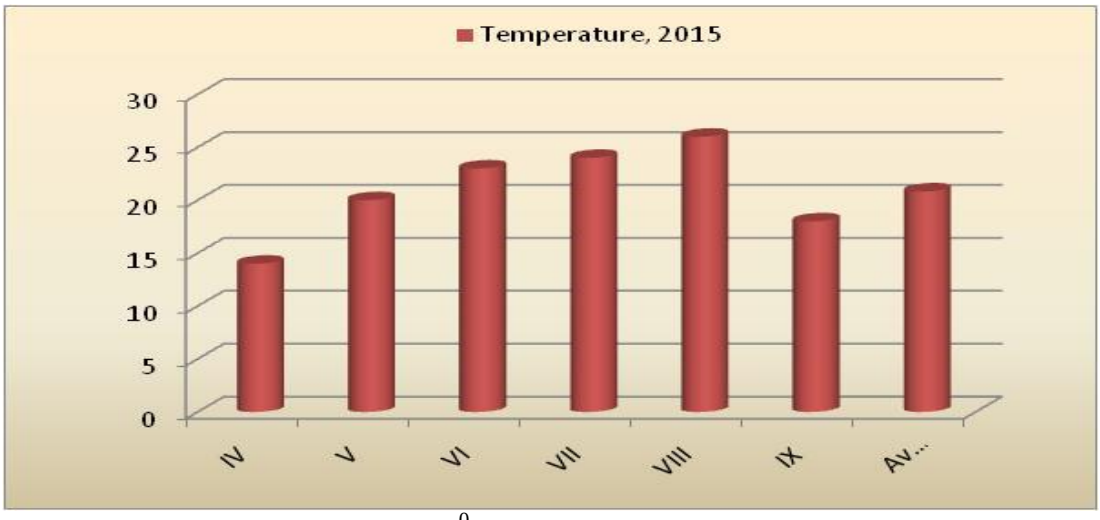
The experiment was carried out in 2015. was performed one factorial field experiment in Stara Pazova, Serbia, chernozem soil, according to a randomized block design with 5 replications. Basic plot size was 10 m^2 (5 m x 2 m). The subject of research were two genotypes of sweet sorghum: Dale and NS Sweet corn (NS Šećerac - In Serbian), created at the Institute of Field and Vegetable Crops in Novi Sad. Sowing was done in the third decade of April. Using standard cultural practices for growing grass. Mowing of plants was carried out at the stage start tasseling in the second decade of July. For the analysis of morphological characteristics (mass of stem and length of panicle) samples were taken from freshly mown biomass.

Meteorological data

Meteorological indicators - precipitation and thermal conditions during the vegetation period of the plants were obtained from the meteorological station Stara Pazova, graph 1 and 2. The quantity and distribution of rainfall varies from year to year, are unpredictable and changeable (Popovic, 2010, Glamoclija et al., 2015 Maksimovic et al, 2016). The total rainfall in the examined vegetation period was 408 mm while the average temperature amounted to 20.83 0C, graph 1 and 2.



Graph 1. Total precipitation, mm, IV-IX mount in 2015, Stara Pazova, Serbia



Graph 2. Average temperature, ^{0}C, IV-IX mount in 2015, Stara Pazova, Serbia

Results and Discussion

The average mass of stem was 175.16 g. Genotype Dale had lower mass of stem compared to genotype NS sweet corn. Difference in mass of stem between the genotypes NS sweet corn and Dala was not statistically significant, tab. 1 graph 3a. The standard deviation for the mass of stem was 9.14 and standard error 2.89, Table 1.

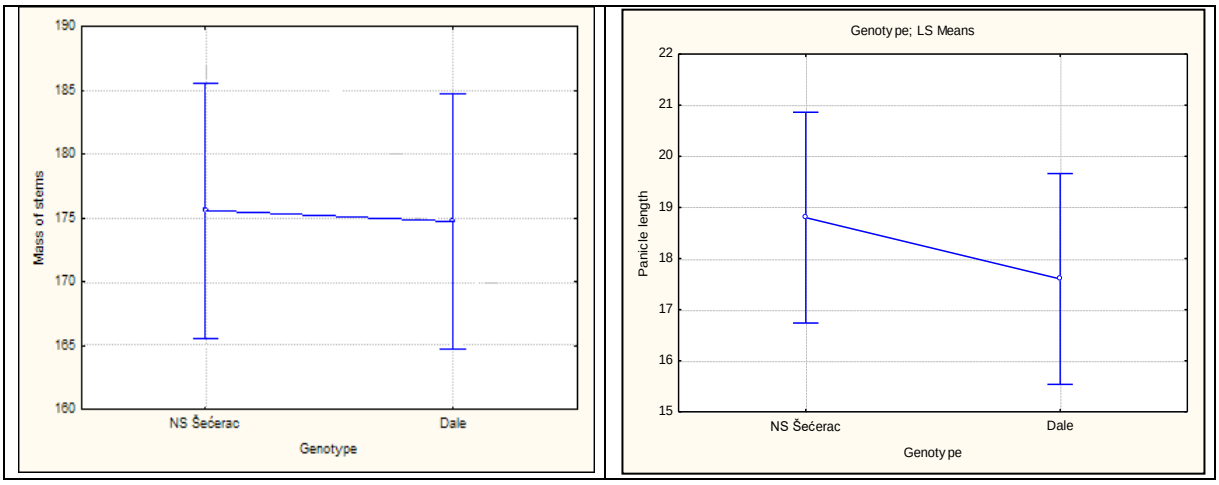
Average panicle length was 18.20 cm. Genotype Dale had a longer panicle compared to genotype NS sweet corn. Difference in the panicle length between genotypes NS sweet corn and Dala was not statistically significant, tab. 1 graph 3b. The standard deviation for the panicle length was 1.99 and standard error 0.62, Table 1.

Based on *Levene*'s Test for Homogeneity of Variances for genotypes had a significantly influence on the mass of stem, Table 2.

Table 1. The morphological traits of the genotypes of sorghum, Stara Pazova, Serbia

Parameters						
Mass of stems (g)						
Genotype	**No**	**Mean**	**Std. Dev.**	**Std. Err**	**-95.00%**	**+95.00%**
NS Sweet corn	5	175.59	12.37	5.54	160.22	190.96
Dale	5	174.72	5.85	2.62	167.46	181.98
Average	10	175.16	9.14	2.89	168.62	181.69
Panicle lenght (cm)						
Genotype	**No**	**Mean**	**Std. Dev.**	**Std. Err**	**-95.00%**	**+95.00%**
NS Sweet corn	5	17.60	1.64	0.73	16.76	20.84
Dale	5	18.80	2.30	1.03	14.74	20.45
Average	10	18.20	1.99	0.62	16.78	19.63

LSD Test	**Mass of stems**	**Panicle lenght**
0.5	14.12	2.92
0.1	20.54	4.25



a.) *b.)*

Graph 3. Average mass of stem (a) and Panicle lenght (b) of tested genotypes, Serbia

Table 2**.** Levene's Test for Homogeneity of Variances for Mass of stems and Panicle lenght

Levene's Test for Homogeneity of Variances; Degrees of freedom for all F's: 1, 8m; Effect: Genotype				
Mass of stems	***MS Effect***	***MS Error***	***F***	***p***
	79.953	*6.671*	*11.985*	*0.008*
Panicle lenght	*0.256*	*1.080*	*0.237*	*0.639*

Correlations of Mass of stem, Panicle length, Temperature and Precipitation

In order to improve sorghum production system, it is necessary to understand the relationships that exist between the individual factors and their impact on productive morphological characteristics of sorghum. It is evident that there is a correlation between the components of morphological characteristics: plant mass, length of panicle and environmental conditions. Mass stem was positively correlated with the panicle length and the temperature and the poor negative correlation with precipitation, table 3.

Table 3. Correlations between tested parameters

Parameter	***Mass of stem***	***Panicle length***	***Temperature***	***Precipitation***
Mass of stem	1.00	0.12 ^{ns}	0.23 ^{ns}	-0.39 ^{ns}
Panicle lenght	-	1.00	0.16^{ns}	-0.41 ^{ns}

^{ns} - non significant
Marked correlations are significant at p < ,05000

Similar results in experiments with broomcorn they had a Sikora et al., (2012, 2013, 2014, 2015). The authors allege that observed highly significant correlation between the components and the quality of panicle environmental conditions. Number of stems per panicle increases in conditions of higher daily air temperature, and decreases with increasing humidity. The authors state that the fineness is positively correlated with average daily air temperature and the total sum temperature during the growing season, while in humid conditions coefficient or smaller fineness.

Sorghum can be cultivated in different soil types (sandy soils, soil heavier texture), tolerates drought and high summer temperatures, better than most cultivated forage plant species. It has a strong root system strong suction power, which grows on those types of land for other plant species less suitable or have low yields. From land uses large amounts of nutrients to achieve high yield, yield responds well to fertilization and irrigation (Pataki, 2012).

Conclusions

The average mass of stem was 175.16 g. The genotype Dale had lower mass of stem compared to genotype NS sweet corn. Average panicle length was 18.20 cm. The genotype Dale had a longer panicle length compared to genotype NS sweet corn.

The recorded the relationship between the components of morphological characteristics: plant mass, panicle length and environmental conditions. Mass of stem was positively correlated with the panicle length and the temperature and the poor negative correlation with precipitation.

Sorghum as a crop species has specific physiological predisposition for tolerance to unfavorable environmental conditions and has the ability to convert solar energy into biomass with high efficiency.

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