STUDY ON THE PRODUCTIVE CAPACITY OF AN ASSORTMENT OF JERUSALEM ARTICHOKE GROWN AT ARDS CARACAL

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Keywords: Jerusalem artichoke, fresh biomass yields, leaves size.

ABSTRACT

Jerusalem artichoke is a plant native to North America, having numerous features from the agronomic point of view, such high growth rate, good tolerance to frost, drought and poor soil, strong resistance to pests and plant diseases and very low requirements related the fertilizers. Usually, Jerusalem artichoke has been used for food or animal feed, but due his chemical compounds it starts to be used for the production of functional food ingredients such as inulin, oligofructose and fructose. The biomass is considered a rich source of ethanol and the production of biogas from Jerusalem artichoke is much higher compared to other energy crops. The variety is one of the main factors of technology, the cultivation of a variety should be done only after a prior test on its adaptability to natural environmental factors. In this paper we present the behavior of 4 tested variety of Jerusalem artichoke cultivated in the conditions of the argic chernozem from the Caracal Plain. The most valuable variety proved to be Olimp, which generate o biomass production of over 49 tons/ha, followed by Rareș variety with 43 tons/ha.

INTRODUCTION

Jerusalem artichoke (Helianthus tuberosus L.) is used for many purposes, such as human nutrition, feed and the production of bioenergy and biochemical products (Li, Wang, Du and Qin, 2013) and is a crop that can be growth under different conditions of environments (Rébora, 2007). It is grown for tubers that can be eaten boiled (in most cases, in soups or other flavored dishes), baked or even raw, for their special taste and nutritional value.

As agronomic importance of the species, Jerusalem artichoke can be grown very well on low fertility soils, being considered a crop that requires minimal work. In fact, high productivity can be achieved, both quantitatively and qualitatively, by using modern technologies where the new genotypes can maximize their yields. Jerusalem artichoke can be grown on a variety of systems and types of crops: in the field, in intensive or sustainable systems (such as organic farming) or in green houses.

As ecological requirements, Jerusalem artichoke is a perennial species resistant to cold and can usually withstand temperatures of -10°C and -15°C, even if the soil is not covered with snow. It is a rustic species, as it can be found in areas such as Alaska (Duke, 1983), but at the same time it can occur in extremely dry areas with high temperatures (Central Spain, Southern Italy, North Africa). The part of the plant that grows outside the soil is sensitive to freezing temperatures and can be destroyed at temperatures below 0°C. Xiao Yong Ma et al., 2011, shows that the optimum temperature for its growth and development is 26.6°C.

Plants are considered the main source of biomass for energy, crops that

produce the largest amount of bulk material in the shortest possible time, so the most useful. Research by White and Plaskett (1981) shows that the maximum biomass production for energy crops of Jerusalem artichoke is about 30 tons / ha. White and Plaskett also claim that biomass has advantages over fossil fuels in that it is renewable, releases less carbon dioxide into the atmosphere and is easy to obtain, cheap and not subject to unpredictable variations in production costs. In general, biomass production is generated by the aerial parts of the Jerusalem artichoke plant, but also the underground parts, the tubers, can be used.

MATERIAL AND METHOD

The research was carried out at ARDS Caracal, during the 2019 year in the conditions of a chermozem soil, medium rich in nutrient and with a humus content which varied between 3% to 4% (Roșculete E. et all., 2019). The soil in the arable layer (0-20 cm) has a lutearic texture with a clay content (particles below 0.002 mm) of 36.2%, an apparent density of 1.42 g/cm^3, a total porosity of 47% and one medium penetration rate (penetration resistance of 42 kg/cm^2).

From the point of view of the hydric features in the superficial layer, the wilting coefficient records the value of 12.3%, the field capacity 24.5% and the hydraulic conductivity is 9.2 mm/h.

The main aim of the research was to test three genotypes of Jerusalem artichoke in order to establish the most valuable genotype for the area of ARDS Caracal.

The experience was based on the randomized block method in three rehearsals. The variants had four rows of 5 meters spaced 70 cm between the rows. The harvested area was 2.8 square meter from the middle rows. As a genotype we test 4 varieties: Dacic - with low port of plants), Rareş, Olimp and Dăbuleni (local population) - with high port of plants.

The preparation of the land for planting was done by plowing at 25 cm in autumn, followed by a 20: 20: 0 complex fertilizer application on a dose of 200 kg/ha applied in the spring during the preparation of the germinating bed and incorporated with two soil mobilization.

Planting was done manually at the end of April at a distance of 45 cm between tubers per row.

During the vegetation period, determinations were made regarding the morphological characters: plant height, average leaf size/plant, average leaf number and average branch/plant. The production of biomass and tubers was done using plots of the middle ranges of the variant.

The calculation and interpretation of the results was performed in comparison with the average/experience, using the variance analysis method ANOVA.

RESULTS AND DISCUSSIONS

Climate conditions. Regarding the temperature, we can say that the agricultural year 2018 - 2019 was an excessively hot year. Compared to the normal zone, an average temperature of 12.7^{o}C was achieved, with +2.1^{o}C higher than the normal zone, which is 10.6^{o}C. Regarding the months of the warm period of the year (April - September) we find that in no month were temperatures lower than the multiannual average. The deviations were positive, between + 0.4 to 3.1^{o}C. It is noted that the months of June, August and September were extremely hot, with a thermal surplus between +2.3^{o}C and respectively +3.1^{o}C.

The rainfall in this agricultural year totaled 647.8 mm, being with 110.4 mm higher than the multiannual average, which for this area is 537.4 mm. During the warm period of the year, the months of August and September are highlighted as very poor in precipitation, when the precipitation deficit was between -49.7 mm and -37.6 mm.

During the vegetation of Jerusalem artichoke, May - September, the total of 508.2 mm, although close to the average value of the area, was not evenly distributed, with the highest distribution in the first part of vegetation, when plant consumption is not significant, and the temperatures were lower, so that the rainwater was mostly unused by Jerusalem artichoke plants. With the onset of the drought, after mid-July and continuing with the lack of rainfall in August and September, amid average daily temperatures that exceeded the average in these months by 3.1°C and respectively 2.4°C, Jerusalem artichoke plants suffered greatly, and that lead to losing more than half of the leaves by drying at the end of August. The water and thermal stress of these months led to the delay of flowering, which was registered at much towards the end of September, and the productive capacity of genotypes was greatly diminished.

Figure 1 – Climatic conditions (temperature and precipitations) of ARDS Caracal in 2019

The variety is one of the main factors of technology, the cultivation of a variety should be done only after a preliminary test on its adaptability to natural environmental factors. Research conducted by Qiwen Zhong et al., 2018 highlighted a relationship between genotypes and the geographical origin of the Jerusalem artichoke variety and its biomass production capacity.

The average height of Jerusalem artichoke plants varied in large limits, due the climatic conditions of 2019 and the morphological features, between 57 cm and 263 cm. The average of plants height reach in these conditions a value of 199.5 cm. Related to this value, the dwarf variety, Dacic, had an average height of 57 cm, followed by Dăbuleni population, which produced plants with an average height of 238 cm and Rares variety with an average of 240 cm. The highest plants were recorded at the Olimp variety, with plants with an average of height of 263 cm (fig. 2 and 3). Similar behavior of those varieties were observed by Ciuciuc Elena at al., 2019, in the conditions of sandy soils from Southern of Oltenia. .

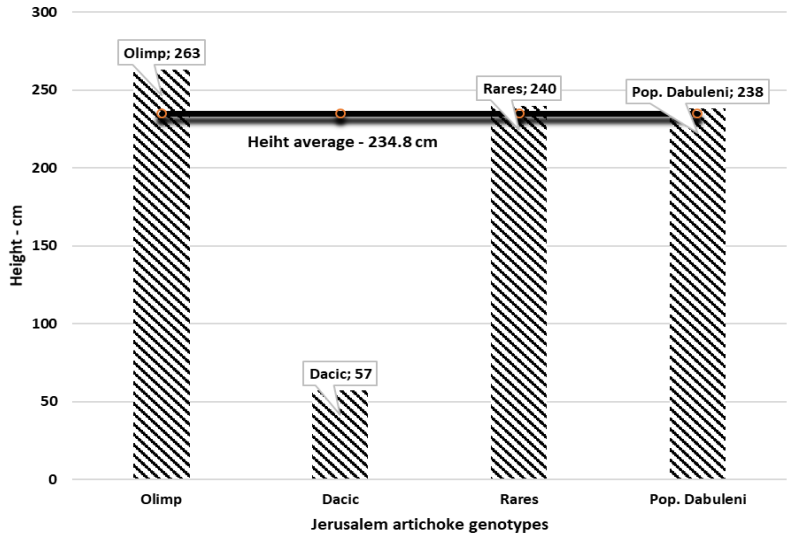

Figure 2 – Plants height in 2019 in the conditions of ARDS Caracal

Figure 3 – Aspect from the experimental field – Dacic variety (dwarf plants) and Rareş variety (tall plants)

At Jerusalem artichoke the aerial stem is straight, with a well-developed mechanical tissue and can reach a height of 3 m or even more. In the culture there are also "dwarf" varieties, as Zubr and Pedersen mentions (1993), having a height under 1 meter. The number of branches varies greatly depending on their position on the main stem. In the case of varieties with very tall stems, in general, the number of tubers is lower.

The leaf is simple, lanceolate or lanceolate-ovate 10-20 cm long and 5-10 cm wide, serrated, pubescent on the underside. The number of leaves per plant varies greatly between cultivated varieties, from 372 to 953 (Swanton, 1986, McLaurin et al., 1999).

In our experiment, the average number of leaves per plant ranged in a very large interval (figure 4) – due the morphological characteristic features of the tested genotypes - from 413.7 registered at Dăbuleni population to 853.1 observed at dwarf variety, Dacic. The latter, although having a small port with dwarf stems, almost creeping, showed a very large number of leaves, in the variant there were individuals whose leaf number exceeded 1000 leaves/plant.

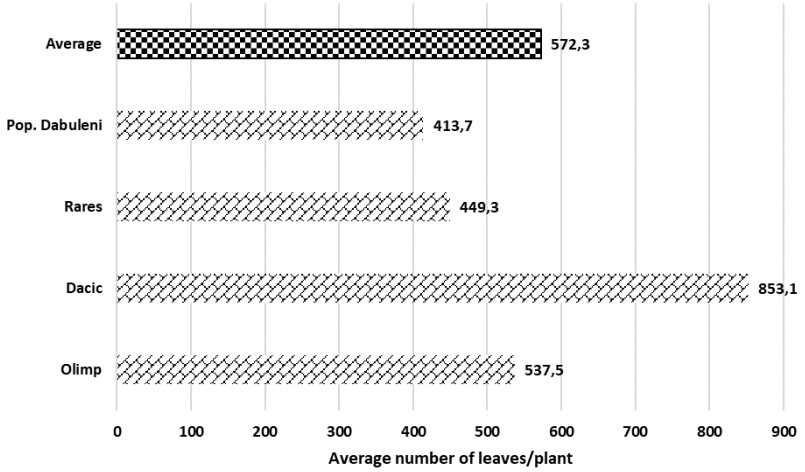

Figure 4 – Varieties average number of leaves/plant in comparison with the average/experiment

Also, related to the plants leaves we determinate and recorded the dimensions of those for each tested genotype (table 1). The registered values were determined on the blooming stage of plants and had large variations of dimensions (length and wide). Leaves length ranged between 8.7 cm on the Dacic variety and 16.7 cm on Olimp variety. Closer values were recorded on Rareș variety, of 16.4 cm. The limits were - the minimum value of 8.1 cm and a maximum value of 23 cm. For this parameter, the average for the experimented assortment was 14.4 cm.

The average dimensions of the wide of leaves in the experiment was 8.1 cm. Related to this value we observed wider leaves on the varieties of Olimp and Rareș with 9.3 cm and respectively 9.1 cm, with the smallest leaves on Dacic variety.

The total biomass yield is influenced by many factors, as follow: plant's density, height of plants, number and dimensions of the leaves and also the number of branch of the plant's stem. Related to this last factor we registered the average number of the branch/plant – which in our case had values ranging between 21.3 branch/plant on Dacic variety and 43.4 branch/plant at Olimp genotype. Closer values of the average branch/plant were observed on the Rareș variety, of 39.4.

Table 1

Some morphological characters registered on the assortment of Jerusalem artichoke cultivated at ARDS Caracal, 2019

Variety	Leaves dimensions - cm -		Average branch/plant
	Length	Wide	
Olimp	16.7	9.3	43.4
Dacic	8.7	5.2	21.3
Rares	16.4	9.1	39.4
Dabuleni	15.7	8.6	36.8
Average/experiment	**14.4**	**8.1**	**35.2**
Minim	*8.1*	*4.6*	
Maxim	*23.0*	*14.0*	

Zu Xin et al., 2015, confirm that Jerusalem artichoke produces a very large amount of green biomass, this being a rich source of biomolecules such as: proteins, essential oils, polyacetylene derivatives, sesquiterpene compounds, phenols, flavonoids and chlorophylls, carotenoids. In contrast, Raso (1990)

argues that Jerusalem artichoke is able to accumulate a large amount of biomass, which requires large amounts of nutrients, however, the crop has a good efficiency in the use of nutrients that has the highest yield of tubers (34 t/ha) on fertile sandy soil with 50 kg/ha N, while the application of a higher amount of N (100, 150, 200 kg/ha) led to a slight decrease in yield.

The fresh biomass yield obtained in the climatic conditions of Caracal Plain had values which rage between 29.4 t/ha at Dacic variety and 49.6 t/ha at Olimp genotype (table 2). In comparison to the Control - the average/experiment, who's value was 38.6 t/ha - significant increase in production were obtained at Rares variety, of 5 t/ha and very significant increase in production were recorded at Olimp genotype, with over 28.5% plus production. Other two varieties, Dăbuleni and Dacic had lower yields related the Control, with 6.8 t/ha and respectively 9.2 t/ha values under the average/experiment.

Table 2

Biomass productions registered on the assortment of Jerusalem artichoke cultivated at ARDS Caracal, 2019

Variety	Biomass yield t/ha	Difference		Signification
		%	t/ha	
Olimp	49.6	128.5	11.0	***
Dacic	29.4	76.2	- 9.2	OOO
Rareș	43.6	113.0	5.0	**
Dabuleni	31.8	82.4	- 6.8	OOO
Average/experiment	**38.6**	**100.0**	**CONTROL**	**CONTROL**

DL 5% =2.1 t/ha; DL 1% = 3.2 t/ha; DL0.1% = 5.7 t/ha.

CONCLUSIONS

Taking in account all results obtained at the Jerusalem artichoke in the 2019 year and in the climatic condition from the ARDS Caracal, we can conclude as follow:

- Jerusalem artichoke found in the Caracal plain good conditions for growing and developing of the plants;
- The climatic conditions of the 2019 had a negatively influence to the evolution of plants in the second part of the vegetative stage with repercussions on the main production's components;
- The best adaptability and capacity of productions, from all the genotypes from assortment, prove to have those varieties with tall port of plants - Olimp and Rares varieties, which realized the highest values on the majority of the morphological characters: plant's height, dimensions of leaves and biomass yields;
- The average biomass yield of 38.6 t/ha falls within the limits specified by the literature;
- Also, we have to highlight Dacic variety with a very good ability to emit shoots and a very good vivacity.

ACKNOWLEDGEMENT

The research was done in the activities of the Project no. 9/PCCDI/2018 VALINTEGR supported by Ministry of National Education UEFISCDI, Program PN III 2017- 2020.

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