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RESEARCH ON THE INFLUENCE OF SOWING TIME ON SUGAR BEET PRODUCTION IN THE CONTEXT OF CLIMATE CHANGE IN CENTRAL MOLDOVA

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Abstract

This paper presents the results obtained from research carried out at A.R.D.S. Secuieni, which aimed to identify solutions to increase the productivity of sugar beet, a crop strongly affected by drought in the specific conditions of the Center of Moldova. To this end, the influence of sowing time on production was analyzed in the experimental field. The growing period of sugar beet was characterized differently depending on the sowing epoch, being very dry for the first two epochs and normal for the third epoch, which benefited better from the large amounts of rainfall in September. The best plant density at harvest was recorded in the third sowing epoch (May 3th), which also achieved the highest root production (48.2 t/ha). Compared with the control variant (average of experience), the increase in production achieved by this variant was statistically assured and interpreted as highly significant. At the opposite pole was the variant sown in the first sowing period (April 01th), which achieved a difference from the control that was interpreted as a very significant negative difference.

Key words: *root yields, climate change, beetroot, cultivation technologies.*

INTRODUCTION

Today, competition for increasingly scarce water resources is becoming very important. The scope for growing water availability is reduced because of the major challenge facing the agricultural sector today to produce more food using less water.

Climate change in recent years has had a significant impact on plant growing cycles (Pochișcanu et al., 2017), including sugar beet production.

Sugar beet (*Beta vulgaris* L.) is the second most important sugar crop after sugarcane, producing about 30% of the total global production and having a high adaptability to different environmental factors, including climate (Naghizadeh et al., 2013). In the early 19th century, the only global source of sugar was sugarcane. Later, sugar beet became one of the most important sources of sugar in the world. Due to its numerous industrial applications, sugar beet is considered a profitable crop (Mukherjee and Gantait, 2023). People need this crop because it provides them with high quality energy and can be used for animal feed. It is a species particularly adapted to temperate regions and its yield is influenced by factors such as soil type, climatic conditions and cultivation technology. Successful cultivation requires a moderate climatic regime with sufficient rainfall and temperate temperatures to develop quality roots and ensure optimal yield (Călin et al., 2019; Nistor et al., 2021). Sugar beets can reduce their yield by about 51% under abiotic stresses, especially drought and soil salinity (Vicente, 2022).

The growth of sugar beet in tropical and subtropical regions to replace or supplement sugar production from sugarcane is increasing

(Abou-Elwafa et al., 2020; Simova-Stoilova et al., 2016). Sugar beet cultivation has many advantages in these regions, including less need for irrigation and its high sugar productivity in a shorter growing season compared to sugarcane (Abo-Elwafa et al., 2013; Abou-Elwafa et al., 2020; Balakrishnan and Selvakumar, 2009). Sugar beet cultivation in developing countries can also be profitable for farmers and the sugar industry by diversifying farmers' income by allowing them to grow an additional crop for commercialization, and by supplying sugar factories with raw material in addition to sugarcane, which can extend the processing season of sugar factories by up to 10 months per year (Abou-Elwafa et al., 2020; Balakrishnan and Selvakumar, 2009; Mandere et al., 2010).

Sugar beet crop productivity is strongly influenced by a number of factors, both technological and environmental (Bocos et al., 2023). Optimization of agronomic practices, which is dependent on climatic conditions, is essential to achieve higher potential and sustainable sugar beet cultivation in the context of climate change. Results of numerous studies have highlighted that the yield potential of sugar beet is directly influenced by the adaptation of cropping technologies to environmental conditions, this fact contend more than the number of plants per unit area (Galal et al., 2022; Elmasry and Al-Maracy, 2023; Hussien et al., 2023). In the context of climate change, which negatively influences plant productivity and quality and severely affects the sustainability of agricultural production, determining the most appropriate sowing date for sugar beet is essential for sustainable cultivation and achieving high sugar beet yield (Curcic et al., 2018). To obtain higher yields there is a need to increase the value of some important parameters in sugar beet crop, such as the diameter of the beetlet, in addition to the number of plants at harvest (Sabaghnia et al., 2024), and this can be done by optimizing some technological sequences. Also, solutions should be found for proper maintenance of the crop, significant increase in weed infestation of sugar beet crop.

Evidence from the literature has emphasized that early sowing leads to earlier maturation of sugar beet and hence earlier harvest, whereas late sowing requires later harvest (Refay, 2010). The determination of an optimal sowing date is one of the most important requirements for successful sugar beet crop (Ezueh, 1982), with numerous recent studies highlighting the complex interaction between sowing time and climatic factors such as temperature, rainfall and drought.

The latest results obtained in the Moldovan area have shown that earlier sowing times favor a better crop start, reducing the risks of late frosts, but have the disadvantage that beet plants are exposed to large temperature fluctuations (Popovici and Grosu, 2023). In the context of climate change in Central Moldova, it has been shown that delayed sowing leads to poor crop growth and development, taking into account the water deficit during the growing season (Popa and Ilie, 2021).

In order to contribute to ensuring stable sugar beet yields in the pedoclimatic conditions of Central Moldova, the SCDA Secuieni studied the influence of sowing time on sugar beet root production.

MATERIALS AND METHODS

In order to achieve our proposed objectives, a single-factor experiment was set up in the experimental field at A.R.D.S. Secuieni, the factor being the sowing time.

The study was carried out in the agricultural year 2023-2024, on a typical Cambian chernozemic soil type, characterized as medium supplied with nitrogen, very well supplied with phosphorus and potassium, well supplied with magnesium, iron sulphur and copper, poorly supplied with boron and molybdenum, and neutral soil reaction (Leonte et al., 2024; Leonte et al., 2023).

The biological material used in the experiment was represented by the hybrid Terrapin Smart which is cultivated according to the Conviso technology, and the rest of the technological sequences applied were those specific for the conditions in the Center of Moldova, following the experimental protocol. Three sowing epochs were experimented, namely:

- Season I - Sown on April 01;
- Season II - Sown on April 16;
- Season III - Sown on May 03.

The crop was fertilized with 200 kg/ha of NPK 15:15:15 complex fertilizer, and the experiment was sown at a row spacing of 50 cm, ensuring a density of 110,000 pellets/ha.
The 2023/2024 crop year was marked by extreme climatic conditions, characterized by constant high temperatures and severe drought, which considerably influenced agricultural crops, including sugar beet. The growing season for sugar beet was characterized by monthly average temperatures higher than the multiannual values, with high positive deviations of up to 4.1°C-4.3°C in July and August. These extreme conditions amplified the heat stress on the crop, negatively affecting physiological processes, such as sugar accumulation, and significantly reducing yield potential. The growing period of sugar beet was 3.1°C warmer than the multiannual average (19.6°C), which emphasizes the need to adapt sugar beet growing technology to the new climatic conditions (Figure 1).

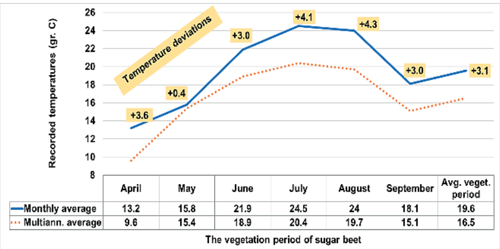

Figure 1. Temperatures recorded at the meteorological station of A.R.D.S. Secuieni, during sugar beet growing season

In terms of precipitation, 2023/2024 was significantly drier, with a total of only 451.8 mm, a deficit of 80.1 mm compared to the multi-year average. The 2023/2024 growing season for sugar beet in crop year 2023/2024 experienced significant rainfall deficits in most months, with the notable exception being September, when heavy rains significantly exceeded the multi-year average. Severe water deficits in May, July and August adversely affected initial plant development and sugar accumulation, amplifying water stress on the crop. Although June had rainfall close to the multiannual average and September brought excessive amounts of water, these conditions failed to offset the impact of the prolonged drought on production. Although 128.6 mm of precipitation accumulated in September, this heavy rainfall came too late to effectively support crop development, the only crop to benefit from it being beet sown in the third sowing season. Overall, total growing season rainfall amounted to 319.4 mm, 57.4 mm below the multiannual average of 376.8 mm (Figure 2).

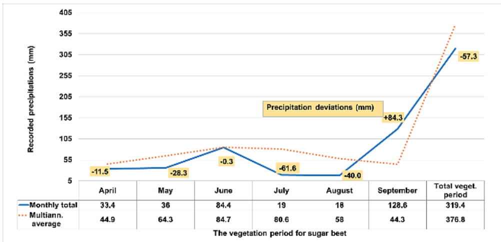

Figure 2. Rainfall recorded at the meteorological station of A.R.D.S. Secuieni, during sugar beet growing season

RESULTS AND DISCUSSIONS

The first sowing was harvested on October 11, the second sowing on October 14 and the third sowing on October 28. A series of determinations were made at maturity and the results showed very wide variations depending on the sowing season.
The number of leaves per plant is a key agronomic indicator for assessing the vegetative stage and yield potential of sugar beet. This parameter reflects the ability of the plant to photosynthesize and thus to accumulate reserve substances in the root. The results showed that the number of leaves varied considerably according to the sowing time, demonstrating the decisive influence of the time of sowing on the development of the leaf apparatus. Under the dry and warm conditions of 2024, late sowing of sugar beet proved beneficial for increasing the number of leaves per plant, with the maximum value of 75.2 leaves/plant being determined in the third epoch. This is mainly due to the fact that the first two sowing epochs were subjected to atmospheric heat for a longer period of time, losing some of their foliage (Figure 3).
The number of roots per square meter is a key agronomic indicator that reflects plant density and directly influences sugar beet yield. This parameter varied according to the sowing time, reaching the highest value in the late sowing, with an average of 11 roots/meter. Late sowing

favored the formation of a higher number of roots per unit area, which can be attributed to the specific climatic conditions that stimulated germination and uniform rooting (Figure 3).

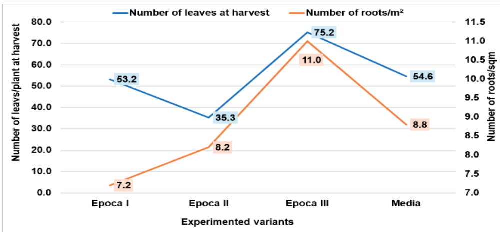

Figure 3. Sugar beet maturity determinations under soil and climatic conditions at A.R.D.S. Secuieni, 2024

After analyzing the data shown in Figure 4, we concluded that a higher number of leaves/plant, indicative of more intense photosynthetic activity, directly contributed to the formation of more roots. Our results emphasize the importance of managing crop factors in sugar beet, such as determining the optimal sowing time, which influenced plant development. This conclusion is supported by the value of Pearson correlation coefficient (r = 0.751155), which indicates a direct and strong relationship between the number of leaves/plant and the number of roots/meter. The coefficient was statistically secured and interpreted as significant.

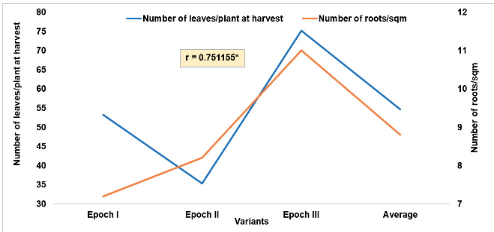

Figure 4. Correlation between the number of leaves/plant and the number of roots/meter in sugar beet, A.R.D.S Secuieni - 2024

The thickness of the beetlet is an essential indicator in assessing the quality and yield potential of sugar beet, having a direct impact on sugar accumulation and plant resistance to different stress conditions. Its values showed significant variations depending on the sowing epoch, with values ranging from 26.8 cm in epoch III (late sowing) to 29.6 cm in epoch II. These results suggest that sowing in seeding time II favored an optimal development of the seed coat, which may indicate a better adaptation of the plants to the specific growing conditions. Late sowing, on the other hand, resulted in a reduction in the thickness of the coleus, which could be explained by a shorter period of active growth (Figure 5).

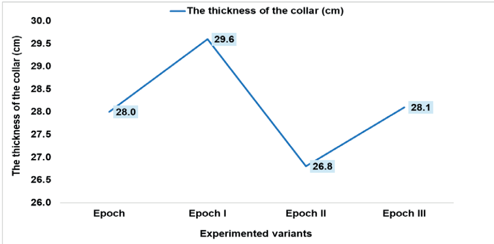

Figure 5. Sugar beet bunch thickness under pedoclimatic conditions at A.R.D.S. Secuieni, 2024

A higher number of roots per square meter at harvesting negatively influenced the diameter of the basket, which was also to be expected in view of the intensified competition between plants for resources. The correlation between the two variables was indirect, with a correlation coefficient r = -0.762156, interpreted as statistically significant negative (o). This relationship emphasizes the importance of ensuring an optimal density at harvest to improve sugar beet quality, with the diameter of the sugar beet boll being a relevant agronomic indicator in this respect (Figure 6).

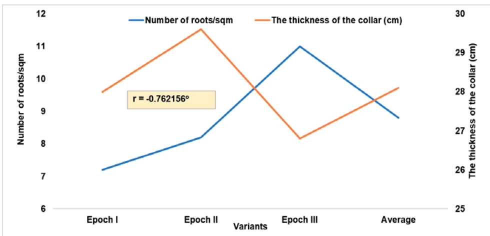

Figure 6. Correlation between the number of roots per square meter at harvest and the diameter of the sugar beet bunch, A.R.D.S. Secuieni - 2024

Sugar beet root yield varied significantly by sowing time, benefiting from different climatic and moisture conditions in plant growth and development.

The lowest yield was obtained in the variety sown in the first sowing season, at 32.2 t/ha. This can be explained by exposure to high temperatures and atmospheric scorch for a longer vegetation period, including sensitive phenotypes. This variant realized compared to the experiment control (mean) a very significant negative yield difference (Table 1).

Sowing beets late, in the third sowing season, was beneficial, with the highest root yield of 48.2 t/ha. This is explained, firstly, by the higher plant density at harvest due to an extremely uniform emergence and, secondly, by the shorter exposure of the crop to atmospheric heat stress at the sensitive growth stages. Compared to the average of the experiment, this variant realized a very significant yield increase (Table 1).

Table 1. Sugar beet root production,
A.R.D.S. Secuieni, 2024

	Epoch	Root Production		The difference from Mt. (t/ha)	Meaning
		t/ha	%		
1	Epoch I	32.2	80	-8.1	ooo
2	Epoch II	40.6	101	0.3	
3	Epoch III	48.2	120	7.9	***
4	Media	40.3	100	Mt.	
DL (t/ha)				5% = 1.9 1% = 2.8 0.1% = 4.0	

The number of roots per square meter is an indicator of crop density, and a well-managed density ensures better area coverage and efficient use of available resources. Each root contributes to the total yield, and a higher number per unit area leads to a proportional increase in yield/ha. In our case, the correlation between the number of roots/meter and the yield/ha was direct and very close, which shows that the beet benefited from sufficient resources for its development. The correlation coefficient (r) attests to this strong relationship between the two variables, with a positive value interpreted as highly significant (Figure 7).

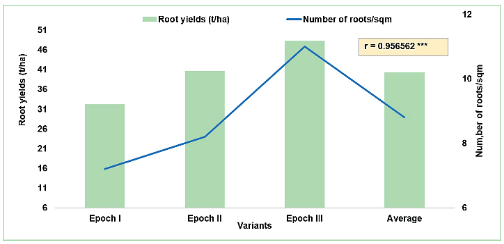

Figure 7. Correlation between number of roots/sq.m and root yield of sugar beet, A.R.D.S. Secuieni - 2024

CONCLUSIONS

The research conducted at A.R.D.S. Secuieni has highlighted the significant influence of sowing time on sugar beet production under climate change characterized by high temperatures and uneven rainfall.

The third sowing time (May 3th) proved to be the most favorable, with a root yield of 48.2 t/ha, a very significant increase compared to the average of the experiment, benefiting from the abundant rainfall in September.

All elements evaluated during the growing period of sugar beet, such as number of roots/meter, number of leaves/plant influenced the root production/ha, either directly or indirectly, thus contributing to the final productivity of the crop.

These results emphasize the need to adapt agricultural technologies to current climatic conditions, highlighting the importance of determining an optimal time for sowing. The implementation of this strategy can contribute to maximize yields and reduce the vulnerability of agricultural crops to water and heat stress.

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