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Testing the Interaction between Agricultural Inputs and Site Specific Climatic Factors in Sugar Beet Production

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Abstract

The sugar beet crop is one of the most important industrial crops, being a main source of sucrose, used in the production of sugar and other food products. Sugar beet needs certain soil conditions, climate and agricultural management techniques to reach its maximum production potential. The aim of the research is to analyze the way in which climatic conditions, namely temperature, precipitation, relative air humidity and wind movements affect the productivity of the fresh substance corresponding to each cultivar. The experiments took place in the experimental field located in the Tritenii de Jos commune area (46°35'10''N, 23°59'47''E). The research involves the productive performance of the Vanghelis, Tesla and Gorilla sugar beet cultivars, in specific climatic conditions, which refer to the area of Tritenii de Jos, Cluj county, during the years 2021-2022. These led to obtaining valuable scientific information about the performance of the cultivars in conditions characterized by specific inputs (fertilization and irrigation), depending on the zonal climatic conditions.

Keywords: correlation, humidity temperature, precipitations, wind velocity.

1. Introduction

The sugar beet crop is one of the most important industrial crops, being a main source of sucrose, used in the production of sugar and other food products. Sugar beet needs certain soil conditions, climate and agricultural management techniques to reach its maximum production potential. The characterization of sugar beet culture involves the analysis of aspects related to environmental requirements, cultivation technologies, disease and pest control, as well as its use [2]. Climatic factors have a significant influence on sugar beet cultivation, determining both productivity and crop quality. Moderate temperatures and regular rainfall are essential for optimal development, as sugar beet prefers cool, moist growing conditions [8]. High temperatures can lead to heat stress, affecting the photosynthesis process and consequently reducing sugar accumulation in the roots [6]. In addition, prolonged periods of drought or excess moisture can have a negative impact on plant health and promote disease development. For example, drought can cause water stress, reducing leaf growth and root yield, while excess moisture can favor the emergence of pathogens that affect sugar beet roots and leaves [1]. Solar radiation also plays a basic role in beet growth, directly influencing photosynthesis and, implicitly, sugar synthesis [9]. In regions with pronounced climatic variability, adaptation through the selection of cultivars resistant to biotic and abiotic stresses becomes a vital strategy for maintaining the stability of sugar beet production. Studies have shown that improving water management and implementing advanced irrigation technologies can partially offset the negative effects of climate change, contributing to stable yields and optimal root sugar concentration [4, 5]. Adequate fertilization management, avoiding nitrogen over-fertilization under heat stress conditions, can help maintain the balance between vegetative growth and root development [3]. Efficient agricultural practices and adaptation of irrigation technologies can contribute to optimizing growing conditions and minimizing the negative impact of rainfall and moisture variability on sugar beet development. By understanding and properly managing the effects of wind movements, farmers can improve the health and productivity of sugar beet crops.

The aim of the research is to analyze the way in which climatic conditions, namely temperature, precipitation, relative air humidity and wind movements affect the productivity of the fresh substance corresponding to each cultivar.

2. Material and Method

The experiments took place in the experimental field located in the Tritenii de Jos commune area (46°35'10''N, 23°59'47''E). The Gorilla sugar beet cultivars [10] Vanghelis and Tesla [11] were studied, the experimental conditions consisted of no irrigation and irrigation with a watering rate of 600 m3/ha per irrigation shift, using 7 shifts over the entire period of vegetation. Regarding fertilization, three strategies were applied: no fertilization, fertilization with the NPK complex in the ratio of 60-40-40 kg/ha, and NPK in the ratio of 180-120-120 kg/ha. Correlations between fresh mass and climatic factors were calculated. After testing the linearity of the parameters, the non-parametric Spearman test was used to calculate the correlation coefficient as an alternative to the parametric Pearson test [7].

3. Results and Discusions

Over the entire experimental period 2021 – 2022, in the Gorilla cultivar, a higher temperature is associated with an increase in fresh mass productivity, regardless of irrigation or fertilization. The strongest correlations are observed in the absence of irrigation (a1b2, r = 0.85 and a1b3, r = 0.80), indicating that under these conditions, temperature plays a major role in the accumulation of fresh mass.

The positive but weaker correlations, ranging between r = 0.10 (a2b2) and r = 0.32 (a1b2), indicate that relative air humidity has a less pronounced effect on fresh mass productivity compared to temperature (Table 1).

Table 1. The simple correlations between the climatic regimen and production, fresh mass, in Gorilla sugar beet variety, 2021 – 2022

Issue	t	H	pp	v
a_1b_1	0.77	0.23	0.52	-0.19
a_1b_2	0.85	0.32	0.57	-0.15
a_1b_3	0.80	0.12	0.43	-0.16
a_2b_1	0.71	0.21	0.42	-0.12
a_2b_2	0.61	0.10	0.43	-0.09
a_2b_3	0.72	0.11	0.56	-0.04

Higher values of relative humidity seem to have a slightly greater positive effect in the absence of irrigation, which may suggest a greater dependence on atmospheric humidity in the absence of soil water. The correlations with precipitation are positive and vary between r = 0.42 (a2b1) and r =0.57 (a1b2). These results indicate that rainfall has a beneficial effect on fresh mass productivity, with a stronger impact in the absence of irrigation (a1b2 and a1b1). It is observed that even under irrigation conditions (a2b3, r = 0.56), precipitation continues to play a significant role, which underlines the importance of water for the growth and development of sugar beet. Negative correlations for wind speed (r = -0.19 to r = -0.04) suggest that wind speed has an adverse effect on fresh mass productivity. Strong wind can cause water loss through evapotranspiration, increasing plant water stress and thus reducing productivity. The impact of wind speed is less negative under irrigation and fertilization conditions (a2b3, r = -0.04), which suggests that irrigation and fertilization can reduce the negative effects of wind movements (Table 1).

In the Vanghelis cultivar, positive and strong correlations (r = 0.61 and r = 0.89) suggest that higher temperatures are beneficial for fresh mass productivity. The strongest correlation is observed in the conditions without irrigation and fertilization (r = 0.89), suggesting a high sensitivity to temperature in the absence of additional interventions. With relative humidity, weak correlations, ranging between r = 0.09 and r = 0.34, indicate that humidity has a minor role in influencing fresh mass productivity compared to other factors. Medium and strong positive correlations from r = 0.42 (a1b3) to r = 0.71 (a1b2) show that rainfall plays an important role, especially under non-irrigated fertilization conditions, which emphasizes the importance of rainfall water for crop growth . Weak and very weak negative correlations (between r = -0.04 and r = -0.19) indicate an adverse effect of wind, but this is less significant than the influence of other climate factors (Table 2).

Table 2.The simple correlations between the climatic regimen and production, fresh mass, in Vanghelis sugar beet variety, 2021 – 2022

Issue	t	H	pp	v
a_1b_1	0.89	0.09	0.55	-0.14
a_1b_2	0.71	0.32	0.71	-0.05
a_1b_3	0.75	0.10	0.42	-0.05
a_2b_1	0.61	0.34	0.61	-0.04
a_2b_2	0.80	0.21	0.54	-0.19
a_2b_3	0.74	0.09	0.48	-0.17

In Tesla cultivar, positive and strong correlations (r = 0.62 and r = 0.82) suggest a similar positive influence of temperature on fresh mass productivity as in Vanghelis. The highest values are observed in the conditions without irrigation and fertilization (a1b1), respectively r = 0.82. In the case of the Tesla cultivar, humidity is positively correlated more strongly (r = 0.39 in the case of the experimental variant a1b1), suggesting a slightly stronger influence of humidity compared to the situation recorded in the Vanghelis cultivar. The positive correlations between fresh biomass productivity and rainfall vary between 0.44 (a1b2) and 0.63 (a1b3 and a2b1), indicating that rainfall has a significant role in influencing it, similar to the situation observed in the Vanghelis cultivar.

With wind speed (v), the negative correlations are weak and fortye (r = -0.01 and r = -0.16, respectively), which shows a minor adverse effect of wind on productivity, similar to the other cultivars studied (Table 3).

Table 3. The simple correlations between the climatic regimen and production, fresh mass, in Tesla sugar beet variety, 2021 – 2022

Issue	t	H	pp	v
a_1b_1	0.82	0.39	0.51	-0.16
a_1b_2	0.77	0.12	0.44	-0.01
a_1b_3	0.64	0.12	0.63	-0.09
a_2b_1	0.72	0.08	0.63	-0.05
a_2b_2	0.62	0.15	0.46	-0.13
a_2b_3	0.73	0.11	0.55	-0.06

4. Conclusions

The conducted research involves the productive performance of the Vanghelis, Tesla and Gorilla sugar beet cultivars, in specific climatic conditions, which refer to the area of Tritenii de Jos, Cluj county, during the years 2021-2022. These led to obtaining valuable scientific information about the performance of the cultivars in conditions characterized by specific inputs (fertilization and irrigation), depending on the zonal climatic conditions. Over the entire experimental period 2021 – 2022, in the Gorilla cultivar, a higher temperature is associated with an increase in fresh mass productivity, regardless of irrigation or fertilization. The strongest correlations are observed in the absence of irrigation (a1b2, r = 0.85 and a1b3, r = 0.80), indicating that under these conditions, temperature plays a major role in the accumulation of fresh mass. The positive but weaker correlations, ranging between r = 0.10 (a2b2) and r = 0.32 (a1b2), indicate that relative air humidity has a less pronounced effect on fresh mass productivity compared to temperature. In the Vanghelis cultivar, positive and strong correlations (r = 0.61 and r = 0.89) suggest that higher temperatures are beneficial for fresh mass productivity. The strongest correlation is observed in the conditions without irrigation and fertilization (r = 0.89), suggesting a high sensitivity to temperature in the absence of additional interventions. With relative humidity, weak correlations, ranging between r = 0.09 and r

= 0.34, indicate that humidity has a minor role in influencing fresh mass productivity compared to other factors. In Tesla cultivar, positive and strong correlations (r = 0.62 and r = 0.82) suggest a similar positive influence of temperature on fresh mass productivity as in Vanghelis. The highest values are observed in the conditions without irrigation and fertilization (a1b1), respectively r = 0.82. In the case of the Tesla cultivar, humidity is positively correlated more strongly (r = 0.39 in the case of the experimental variant a1b1). In Tesla cultivar, positive and strong correlations (r = 0.62 and r = 0.82) suggest a similar positive influence of temperature on fresh mass productivity as in Vanghelis. The highest values are observed in the conditions without irrigation and fertilization (a1b1), respectively r = 0.82. In the case of the Tesla cultivar, humidity is positively correlated more strongly (r = 0.39 in the case of the experimental variant a1b1), suggesting a slightly stronger influence of humidity compared to the situation recorded in the Vanghelis cultivar.

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