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THE INFLUENCE OF THE CULTURE SYSTEM AND THE HYBRID ON PRODUCTION AND ECONOMIC EFFICIENCY FOR SWEET CORN

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Abstract

The paper presents the results of the study regarding the behavior of two hybrids of sweet corn and the economic efficiency of this culture, established in two culture systems, in the field and in solar greenhouse. The experience took place in 2021, in southern Romania, on a psamosoil type soil, 43°48'04"N 24°05'31"E. The biological material was represented by the hybrids Sweet Thing F1 and Dessert R78 F1 grown in open field and in solar greenhouse. The specifics of the variants were as follows: V1- Sweet Thing F1- culture in solar greenhouse; V2- Sweet Thing F1 - field culture; V3- Dessert R78 F1- culture in solar greenhouse; V4- Dessert R78F1 – field culture. The control of the experience was the average of the variants. In order to assess the behavior of the hybrids, determinations were made regarding morphological characters, production capacity and economic efficiency for both culture systems.

The results regarding the influence of the culture system on the morphological and production characters indicate for both hybrids higher values in solar greenhouse system, compared to the results recorded in field culture. In the field, production was lower, being affected by the increase in temperatures during the pollination period, over 30^0C. Regarding the influence of the hybrid on sweet corn production, Sweet Thing F1 performed best both in the field and in solar greenhouse - 11.2 t/ha. Concerning the crop of sweet corn in a solar greenhouse, the profit rate was three times higherthan the crop in the field due to the earliness of the crop and the higher selling price.

***Key words**:Key words:Zea mays convarsaccharata, Sweet Thing F1, Dessert R78 F1*

INTRODUCTION

Sweet corn (*Zea mays* L. group saccharata) is native to the USA and from here it was introduced to countries around the world, with increasing popularity among consumers as a favorite vegetable choice (Reveilla et al., 2021). This species has become an interesting culture in Europe as well. In Romania, it is one of the most recent crops, with the cultivated areas increasing in recent years. The economic and nutritional value of sweet corn as well as the different ways of consumption determined the expansion of the species.

Sweet corn is grown for fresh consumption, boiled or baked, but also represents raw material for processing, to obtain wet cans. Texture, sweetness and aroma are basic characteristics for quality and consumer demands. The sweet, juicy and good tasting seeds are in the milky stage (Ugur and Maden, 2015).

Unlike maizewhere the kernels are harvested when they are dry and mature (dent stage), sweet corn must be harvested when it is immature (milk stage) and prepared and consumed as a vegetable rather than a grain (Ronley and Canatoy, 2018). Sweet corn is also richer in protein, fat and sugar (Budak and Aydemir, 2018).Global sweet corn production is increasing due to its high economic value (Altinel et al., 2019). The high yield may be due to the introduction of new high-performance hybrids and improved technology.

Sweet corn culture is limited from an agronomic point of view by the climatic conditions of the culture area (temperature, soil fertility or water stress). These can cause a weak germination and implicitly a weak vigor of the plants which is reflected first of all in the early production and then in the quality characteristics of the grains. In principle, all aspects of sweet corn production are affected by natural limitations as well as the genetic background used.

In Romania, the Agricultural Research Station Turda, carried out a genetic improvement program to obtain sweet corn based on the infusion of the sugary-1 recessive gene to a series of normal inbred lines (Pacurar -Grecu et al., 2018) and also, since 1980, it initiates programs for the production of superior local hybrids, with a short vegetation period and highquality yield (Has and Has, 2009). Worldwide, research on this species has evolved a lot, even the color of the endosperm being of great importance. European colonists originally cultivated sweet corn with white endosperm (Y1Y1), along with the introduction of the 'Golden Bantam' variety with yellow endosperm, it became the new standard. Many of the white endosperm cultivars were then crossed with Golden Bantam and turned yellow (Revilla et al., 2021).

Time of establishment and choice of genotype are key factors in the management of sweet corn crops to obtain economically efficient yields. The establishment season should be timed so that the growing stages do not coincide with high temperatures and midsummer drought. Sweet corn is a thermophilic crop with an optimal growth temperature of 20-22 °C and not exceeding 30-32^{0}C, and if low temperatures intervene (of 4-5^{0}C) after plant emergence, growth stops (Soare, 2022).

For obtaining high-quality sweet corn are important several factors such as: rapid growth, adequate soil moisture and nutrient supply, and harvesting at optimal maturity (Ronley and Canatoy, 2018).

The increasingly accentuated climate changes that have occurred in recent years and the greater spread area of sweet corn have imposed new ways of cultivating this species as well as a more detailed research depending on each culture area.

The purpose of this study was to evaluate the morphological and production characteristics of two sweet corn hybrids, cultivated by seedling production in two crop systems (field and greenhouse solar) as well as the economic efficiency of the crop systems.

MATERIALS AND METHODS

The experience took place in 2021, in southern Romania, on a psammosol type soil, 3°48′04″N 24°05′31″E. The biological material was represented by the hybrids Sweet Thing F1 and Dessert R78.

Sweet corn culture was established by producing seedlings both in the field and in protected areas. The experimental model consisted of the following four variants: Sweet Thing F1- culture in solar greenhouse; V2- SweetThing F1 - fieldculture; V3- Dessert R78 - culture in solar greenhouseand V4- Dessert R78 - fieldculture.

From a technological point of view, the culture of sweet corn was carried out based on the specific technology, by producing seedlings.

In order to obtain the seedlingin culture om greenhouse it was sown on February 18, and for the culture in the field, the seedling was sown on March 4. An optimal germination temperature of 20^{0}C was ensured. Next, general seedling care works were applied by managing the vegetation factors and ensuring the health and vigor of the seedlings.

Planting of seedlings in the greenhouse was done on March 25 in rows at a distance of 70 cm, and between plants in a row the distance was 25 cm resulting.

Planted in the field, it was carried out after setting up the drip system and mulching with thermal film on the ground, 2 weeks later compared to the culture in the solar on April 6.

After planting in the field, protection was achieved through a tunnel covered with transparent polyethylene film. After 25 days from planting, when the air temperature increased, during which ventilation windows were also made, the foil on the tunnel was completely removed.

To evaluate the influence of the hybrid and the culture system on production, morphological determinations were made: plant height, cob insertion height,cob length, number of rows of seeds/cobs, average weight /cob, productivity, both for culture in protected spaces and in the field.

In order to assess the economic efficiency of the two types of culture (field, protected areas), a range of indicators grouped as follows was used: income indicators (gross product determined by adding up the main production, secondary production and subsidies - lei); expenditure indicators - expressed in lei (which includes variable expenses and fixed expenses; variable expenses are composed of fertilizers, pesticides, seeds, seedlings, irrigation, mechanical works, seasonal labor expenses, crop insurance, supply; fixed expenses include expenses with the permanent workforce, general expenses, interest on loans, amortization, lease; profitability indicators (gross margin - lei, gross profit - lei, income tax - lei, net profit - lei, gross profit rate - %, net profit rate - %) (Pânzaru, 2015). We mention the fact that the indicators were determined for the area of 0.50 ha for the crop in the field and for an area of 0.10 ha for the crop in the solar.

RESULTS AND DISCUSSIONS

To assess the morphological and productivity characteristics, determinations were made to highlight the behavior of the hybrids studied both in protected areas and in the field.

Analyzing the morphological characters, differences are observed regarding the stem height and the cob insertion height, determined by the hybrid. Thus, the average stem height was between 175.5 cm (V4) and 200.8 cm (V1). It can be seen that for the culture in the field the values were lower, unlike the plants in the greenhouse where the values were slightly higher (Table 1.). The highest percentage increases were found in the Sweet Thing F1 hybrid, being 7.8% higher than the experimental control.

Table 1.The main morphological characters in sweet corn hybrids(mean values)

Variants	Plantheight		Cobinsertionheight	
	cm	%	cm	%
V1- SweetThing F1- culture in solar greenhouse	200.8	107.8	63	110.0
V2- SweetThing F1 - fieldculture	186.3	100.0	56	97.8
V3- Dessert R78 - culture in solar greenhouse	182.5	98.5	60	104.8
V4- Dessert R78 - fieldculture	175.5	94.2	50	87.3
Averagevariants - Control	186.2	100.0	57.25	100.0

Regarding the insertion height of the cob, it was between 50.0 cm (V4) and 63.0 cm (V1), highlighting also for this morphological character the culture in the protected space (Table 1.).

Concerning the productivity elements, determined at the time of harvest, at technological maturity or consumption, it was found that the length of the cob, the number of rows of grains/cobs and the average number of grains/cobs varied both between hybrids and between variants.Among the hybrids studied in the greenhouse, the cob length recorded higher values, at Sweet Thing F1 of 23 cm, followed by Dessert R78, with 21.4 cm. The lowest values were recorded in both hybrids in the varieties grown in the field. The percentage increases were between 101.6-109.2 (Table 2). Similar results were reported by Erdal et al., (2011) regarding cob length from 18.5 cm to 20.4 cm, in cropping system, in the field.

Table 2. The main morphological characters in sweet corn hybrids(mean values)

Variants	Coblenght		No. rows/cob		No. grain/cob	
	cm	%	no	%	no	%
V1 - Sweet Thing F1- in solar greenhouse	23.0	109.2	20.0	108.7	800	115.9
V2 - Sweet Thing F1 - field culture	20.6	97.86	19.6	106.5	720	104.3
V3 - Dessert R78 - in solar greenhouse	21.4	101.6	16.6	90.2	622	89.8
V4 - Dessert R78 - field culture	19.2	91.2	17.4	94.5	618	89.5
Average variants - Control	21.05	100.0	18.4	100.0	690	100.0

It can be said that the variability regarding the size and development of the cob can be attributed to several factors, especially the hybrid (Lazcano et al., 2011) as well as the culture system applied, statements. According to other authors, the small dimensions regarding the length of the cob may be the result of stress caused by drought, which causes a decrease in photosynthesis and implicitly a decrease in biomass accumulation (Rivera Hernandez et al. 2010; Soare et al., 2019).

The number of rows of grains/cobs varied from 16.6 (V3) to 20 (V1), depending on the variant and hybrid. In the present study, this character is more influenced by the hybrid. The results are consistent with Farsiani et al., (2011) who stated that the number of grain rows per cob is influenced more by genetic factors than crop management.The average number of grains/ears recorded a range of variation from 618 (V4) to 800 (V1). The highest values were recorded for Sweet Thing F1 in the version planted in a protected space and the lowest for Dessert R78, in the version planted in the field. It can be seen that the values are influenced by both the hybrid and the culture system.

Regarding the time of harvesting in the protected space, it was carried out on 30.05, then, the second harvesting approximately one week later, on 07.06, and in the field the harvesting was carried out on 11.06, respectively, the second harvesting on 17.06. The difference between the harvesting period from the field compared to that from the solar was 12 days, a factalsoduetotheimprovement of thetechnologicalsequencesappliedtotheculture in thefield (mulch film, film tunnelapplied 25 daysafterplanting).

The most important aspect of maize cultivation, both for researchers and farmers, is the production capacity (Bonea et al., 2015). Regarding the average weight of the cob, an important element of productivity, it recorded variations from 186.1 g (V4) to 250.3 g (V1) (Table 3), the percentage differences compared to the control are greater in the system of culture in solar, being between 2.4 and 14.2%. The higher values are registered for Sweet Thing F1 hybrid. In this case, the higher cob weight is correlated with their length and the average number of grains/cob, the hybrid with the longer length also had a good yield, similar observations made by other researchers (Erdal et al., 2011).Fresh cob production recorded a range of variation from 8.5 (V4) to 11.2 t/ha (V1). Sweet Thing F1 produced superior yields compared to the experience witness, both in the greenhouse-solar culture system and in the field. It can be stated that production is correlated with cob size and cob weight (Table 3).

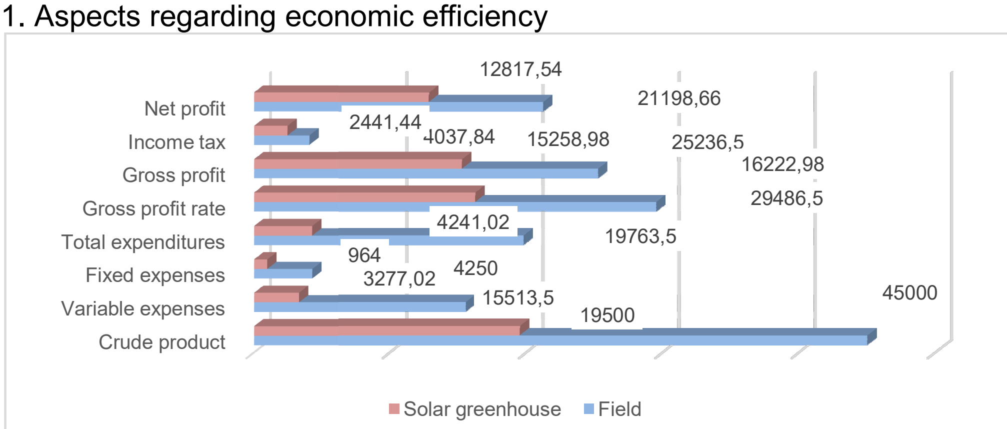
Table 3. The yield at sweet corn hybrids

Variants	Weight cob (g)	Fresh cob yield (t/ha^{-1})
VSweetThing F1- solar greenhouse	250.3a	11.2a
V2 - SweetThing F1 - fieldculture	215.7a	10.7a
V3 - Dessert R78 - solar greenhouse	214.5a	10.4a
V4 - Dessert R78 - fieldculture	186.1b	8.5b
P5%	26.41	1.62

According to Fahrurrozi et al., 2021, the production of sweet corn can be influenced by the organic and inorganic cropping system, being 29% lower than the sweet corn grown in the inorganic production system.The superior results in greenhouse-solar compared to those in the field could be due to the fact that the establishment of the culture in the solar has benefited from optimal time and conditions for adequate plant growth compared to the field culture system where temperature fluctuations can occur at the beginning period or high temperatures that affect cob development and seed formation.

In terms of economic efficiency, for field culture it is possible to observe a structure of expenses in which the variable ones predominate (78.49%) to the detriment of the fixed ones (21.51%). The main elements are seed and seedling (61.02%) and fertilizers (13.91%). In the case of cultivation in the solar greenhouse, the structure of expenses was: 77.29% variable expenses and 22.71% fixed expenses. Among the variable expenses, seed and seedlings (61.56%) and fertilizers (13.91%) remain dominant. Although most of the expenses incurred both in the field and in protected areas were the same relative to the weight of the work performed, the rate of profit was three times higher in the solar crop than in the field(Figure 1).This fact was due to the higher marketing price, considering that the harvesting of the sweet corn from the solar was carried out about 10 days earlier.

Figure 1. Aspects regarding economic efficiency



In the case of the synthetic indicators, it can be observed that the hybridscultivated in solar produces net superior economic results (the gross profit rate, respectively the net profit rate are 2.82 times ahead of the existing situation in field cultivation) (Figure 2).

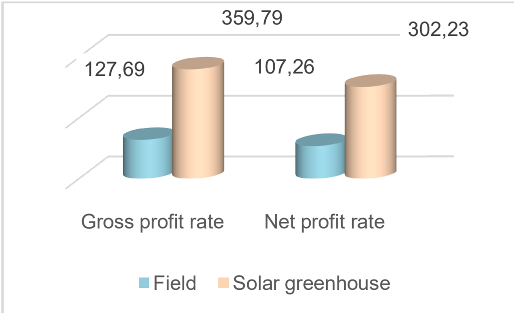


Figure 2. Synthetic indicators of profitability (%)

CONCLUSIONS

Sweet Thing F1 and Delicios F1 hybrids recorded superior values for morphological and productivity characters in the greenhouse-solar system compared to those recorded in the field culture. We can say that the variability regarding the size and development of the cob can be attributed especially to the hybrid, but also to the culture system. Regarding the influence of the hybrid on sweet corn production, Sweet Thing F1 performed best both in the field and in protected areas, being 10.7 and 11.2t/ha, respectively. In the field, production was lower, being affected by the increase in temperatures during the pollination period. From an economic point of view, it is recommended to practice, above all, the culture in protected spaces for early productions and advantageous sales price.

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