

## STUDY ON THE INFLUENCE OF ENVIRONMENTAL CONDITIONS FROM GREENHOUSE ON THE ACCUMULATION OF VEGETATIVE MASS AND FRUCTIFICATION IN SOME VARIETIES OF CHERRY TOMATOES

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### Abstract:

*The preliminary study was carried out in Hortinvest greenhouses on two varieties of cherry tomatoes, 'Flaviola' and 'Cheramy' F. The environmental factors in the greenhouse, temperature, atmospheric humidity, CO<sub>2</sub> concentration inside the greenhouse during January-March were registered. Also, the obtained productions and the vegetative mass of the leaves were registered. We found that for the 'Flaviola' variety, the temperature had a greater influence on the production compared to the 'Cheramy' variety. We noticed that each variety reacted differently both in terms of temperature and CO<sub>2</sub> values. The accumulated vegetative mass was higher in 'Cheramy F1' compared to 'Flaviola', this being a genetic characteristic of the variety. The percentage of fruits obtained per plant was 54.75% and only 45.25% of the vegetative mass in 'Cheramy F1'. For the 'Flaviola' variety, the percentage of fruit was 60.64% and 39.36% vegetative mass. The aim of the study was to analyse the behaviour of some varieties on total production.*

**Key words:** tomatoes, cerise, cultivars, substrate.

### INTRODUCTION

Currently, the production of tomatoes in the greenhouse is constantly growing due to the application of new high-performance technologies that ensure very high yields. At the same time, consumers are looking for quality fruits, of different sizes, shapes, colors and with specific flavors. In greenhouses, were grown mainly, varieties with large, spherical fruit, but now are increasingly appreciated tomatoes with cherry fruits (*Lycopersicon esculentum* var. *cerasiforme*), due to their aroma, content also balanced in carbohydrates and vitamin C and ornamental effects (Dinu et al., 2015). Another aspect regarding the extension of cherry tomatoes in the culture is their high price but also the ability to better adapt to variations in environmental factors.

In the greenhouse, one of the important objectives is to reduce the temperatures in the growing space, especially in periods of strong sunshine and to maintain values corresponding to obtaining high and quality yields. Studies have shown that high greenhouse temperatures influence productivity but also nutritional quality (Bitaand and Gerats, 2013; Adams et al., 2001).

The use of shading screens can reduce the temperature inside of greenhouses, but if they are not supported by other air conditioning systems, they reduce their efficiency, leading to the compromise of tomato cultivation.

Tomatoes are very pretentious of temperature. Temperatures below 10°C block the growth of plants and the phenomenon manifests itself in the form of short knotting of the growth tips and the size of the leaf petiole decreases.

(Gertsson, 1992; Luxhoi, et al., 2007; Grimstad, 1993; Heuvelink and Dorais, 2018). The negative effect is even more obvious in conditions of insufficient light (Pescar Svetlana, 2013).

At temperatures above 40°C, plant turgidity decreases, followed by wilting and drying of growth tips. The optimum temperature range for growth and fruiting is 18-32°C but at temperatures above 35°C pollen viability decreases.

Hussainet et al. (2001) cited by Abdelmageed and Gruda (2009) says that the number of fruits per plant and the percentage of fruits was lower due to the high temperature.

Temperatures of 15-16°C during the formation of flowers, for long periods, determine abundant flowering, the flowers can remain open on the plant for several weeks but without forming fruit, the flowers are larger and the inflorescence branches a lot. Also, temperatures below 10 °C during flowering can affect pollination but can also cause fruit cracking and affect fruiting. Temperatures above 35 °C during the ripening period of fruits negatively influence their coloration due to the reduction of the synthesis of red pigment (lycopene) and the increase of the synthesis of yellow pigment (carotene).

Zhang et al., 2012, state that exposure of tomato plants to an extremely high temperature of 35°C for eight hours reduced the rate of photosynthesis.

Another phenomenon that can occur during the physiological maturation of fruits is due to the maintenance in the greenhouse of low temperatures of 15-18°C day and night, below the recommended temperature of 20-24°C during the day and 18°C at night but also of a low level of potassium in the nutritional recipe. In this situation, the fruits have an inappropriate appearance, they give the impression of fruits that have not reached physiological maturity, but if we cut a fruit, it is found that the seeds are already sprouted.

Large differences between day and night temperatures can increase the period of fruit growth (Van der Ploeg and Heuvelink, 2005), however, a large difference results in a more generative increase (Heuvelink, 1989; Peet and Welles, 2005 quoted by Noemi et al., 2014). Temperatures below 10°C inhibit vegetative

growth, delay fruit ripening, and those above 35°C inhibit fruiting, fruit development and coloration. Zhang et al., 2012, state that exposure of tomato plants to an extremely high temperature of 35°C for eight hours reduced the rate of photosynthesis

Temperatures above 22°C correlated with high atmospheric humidity above 80% create optimal conditions for the development of the pathogen *Cladosporium fulvum*, and at temperatures below 15°C and relative air humidity above 75% create optimal conditions for the attack of *Phytophthora infestans*.

Greenhouses and high tunnels capture solar radiation so that, especially in summer, the temperature inside the culture space increases, creating the greenhouse effect. Ventilation systems eliminate excessive heat and ensure adequate conditions for the growth and development of tomato plants. Modern greenhouses have computerized operating systems that monitor all plant growth parameters.

Even in low light conditions, increasing the CO<sub>2</sub> content during the reproduction phase induces early flowering and fruit formation (Grouda, 2005; Sima et al., 2011), increases the net assimilation rate, plants can photosynthesize more at concentrations higher levels of CO<sub>2</sub> (Heuvelink and Dorais, 2005; Grouda, 2005; Singh, et al., 2005; Sima et al., 2011). Additional CO<sub>2</sub> fertilizations of up to 800-100 ppm can be performed in the greenhouse. In professional greenhouses, of the latest generation, all environmental factors can be monitored, that is essential for achieving high yields. Also, the light factor can be easily controlled and we can provide the necessary in the culture space, especially in the autumn-winter or spring periods. Low light intensity, short photoperiods and high night temperatures can be important limiting factors for fruit formation (Wittwer and Honma, 1986).

Supplementing light in greenhouses is necessary especially in periods of strong cloudiness, but also in autumn when the number of lighting hours decreases (Panțer et al., 2016).

Another factor that we must take into account and which in modern greenhouses can be well controlled is atmospheric humidity.

It is known that both low and very high atmospheric humidity affect pollination. Also,

the very high atmospheric humidity correlated with the lack of aerations determines the appearance of adventitious roots on the stem in some varieties.

The work of removing the leaves must be done with great caution (Buitelaar and Janse, 1987; Buitelaar, 1989; Xiao et al., 2004).

The assortment grown in the greenhouse must be chosen according to the specific requirements of the cultivars.

In terms of nutrients, they can be well monitored, they are used effectively on phenophases. Tomatoes intensively capitalize on mineral resources (Dinu et al., 2019; Dinu et al, 2015; Kostadinov, 2020).

Numerous studies on fruit yield at the end of the crop (Papadopoulos and Ormrod, 1991), De Koning, (1990b) (quoted by Heuvelink, 1996) have shown that 74.3% of the total fresh mass of the plant is the fruit and only 23.7% vegetative mass (stem and leaves). Kleinhenz et al. (2006) obtained a different plant biomass depending on the plant density, this being 16-19% with 13% higher in the case of driving on two stems.

The EC of the solution is well monitored as well as the amount of nutrient solution. Moreover, the nutrient solution resulting from the drain is recovered, rebalanced, disinfected and reused. The temperature of the nutrient solution reached in the culture substrate is distributed at values of 20°C, with a direct effect on tomato production. Also, the pH of the nutrient solution can be controlled and maintained constantly at values in accordance with the nutritional recipe.

Regarding the culture substrates, organic substrates (coconut, peat, compost, etc.) or inorganic substrates (mineral wool, perlite, vermiculite, zeolite, etc.) can be used depending on the geographical area. When choosing the type of substrate, their characteristics and physical properties must be taken into account: total porosity; substrate density; water retention capacity; be able to drain the solution.

From a chemical point of view, the substrate must not interact with the nutrient solution, nor must it solubilize or favor the transfer process (Jerca et al., 2015; Drăghici et al., 2019).

All these aspects lead to the support of modern cultivation technologies in a soilless system. Regarding the cultivated assortment, hybrids

with both large fruit of over 120 g/fruit and a cherry-type assortment are chosen, especially very appreciated by consumers.

In the present study we analysed the behaviour of some cherry tomatoes in greenhouse conditions on perlite substrate. I used these crops because they have very high plasticity although they are intended for soil crops.

## MATERIALS AND METHODS

The study was carried out within the Hortinvest research greenhouses, which belong to the Research Center for quality control of horticultural products, Faculty of Horticulture, USAMV Bucharest. The greenhouses are modern constructions with high of 6.2 m, and which are equipped with all the facilities for monitoring and maintaining the climatic factors in the greenhouse. We used as biological material 2 cultivars of cherry 'Cheramy F1' (V1) type tomatoes and a Romanian variety, 'Flaviola' (V2), created at the Buzău Vegetable Research Station. The culture was established in a soilless system, on mattresses filled with perlite with a grain size of 4 mm from SC Perlit SA, Ilfov County.

The duration of the experiment was 90 days.

I watched the parameters of vegetative growth in height, number of leaves and fruiting. We determined the number of inflorescences as well as the number of fruits in the inflorescence. Fruit production per plant was weighed. We recorded throughout the experiment the values of temperature, relative humidity through sensors located at a height of 1.5 m inside the greenhouse.

'Cheramy F1' is an early-maturing hybrid with undetermined growth. The fruits are of the cherry type, around 15 g/fruit

'Flaviola' variety presented an indeterminate vegetative growing, with fruit cherry type, recommended to crops in protected area.

The temperatures from greenhouse were recorded daily during 24 hours, day and night, for 90 days also light radiation, atmospheric humidity and CO<sub>2</sub> concentration.

During the vegetation was recorded the total amount of vegetative mass (leaves and stem) as well as the amount of fruits harvested during the entire period under observation (1 January-30 March 2021).

The area cultivated with tomatoes in the greenhouse was 160 m<sup>2</sup>. A number of 154 plants of ‘Cheramy F1’ and 101 plants of the ‘Flaviola’ variety were analysed.

The data were recorded and correlated to see the influence of environmental factors in the greenhouse on the production and accumulation of vegetative mass.

### RESULTS AND DISCUSSIONS

The recorded data showed that in January the minimum and maximum values of light radiation were between 77.69 W/m<sup>2</sup> and 649.29 W/m<sup>2</sup>. During this period, the plants were in the phenophase of vegetative growth and beginning of formation but also of fruit maturation.

In February, the value of the recorded radiation showed higher values compared to January, being between 788.78 W/m<sup>2</sup> and 864.07 W/m<sup>2</sup>. During this period, tomato plants were found both in the phenophase of fruit growth as well as in that of intense maturation.

In March, the values of solar radiation also increased with the increase of the lighting duration, reaching in some days, minimum values of 127.5 W/m<sup>2</sup> and 162 W/m<sup>2</sup> and maximum values of 611 W/m<sup>2</sup> respectively 967.13 W/m<sup>2</sup>, and for short periods at 1132.75 W/m<sup>2</sup> (Figures 1-3).

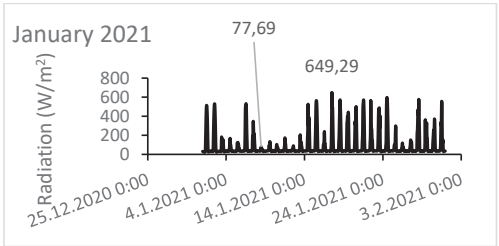


Figure 1. Solar radiation recorded in the greenhouse in January

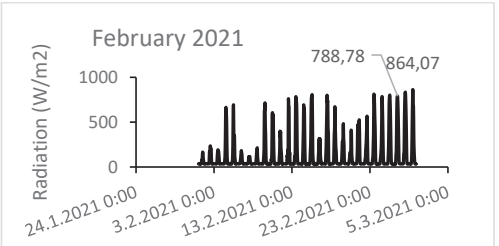


Figure 2. Solar radiation recorded in the greenhouse in February

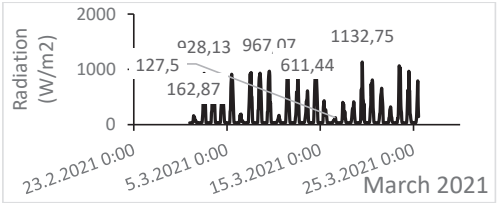


Figure 3 Solar radiation recorded in the greenhouse in March

Analysing the environmental factors in the greenhouse, between January 1 and March 30, 2021, we found that the temperature values were different both from one month to another and during one day (24 hours).

The temperature values registered outside the greenhouse, throughout the study period, reached in January minimum values of -6.91°C and maximum values of 12.48°C.

In February, outside the greenhouse, were recorded negative temperatures from February 10 to February 25. The lowest values were between -7.88°C and -0.3°C. In the rest of the period, only positive temperatures of over 20.47°C were recorded.

In March, were recorded, only for short periods, negative outdoor temperatures of -0.5°C or -2.1°C and temperature maximums of 17.9°C (Figures 4-6).

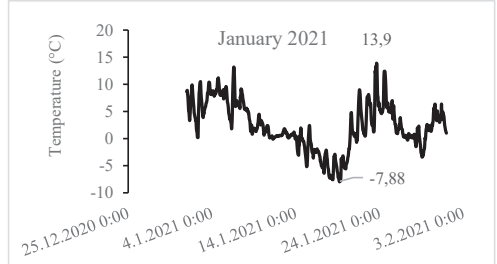


Figure 4. The temperature recorded in the greenhouse in January

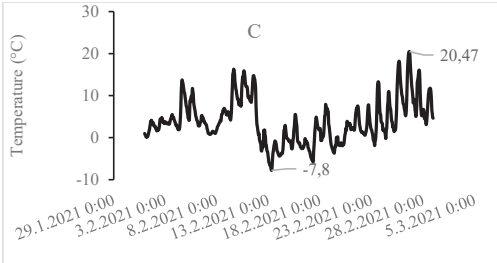


Figure 5. The temperature recorded in the greenhouse in February

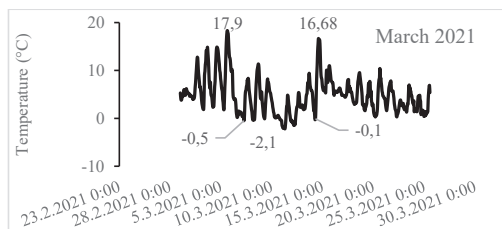


Figure 6. The temperature recorded in the greenhouse in March

In January, the lowest minimum temperatures recorded in the greenhouse were 14.8°C and 15.3°C, respectively. During the rest of the period, the temperatures ranged between 18°C and 22.5°C, depending on the temperature accumulations during the day.

The maximum of temperatures recorded in the greenhouse reached values of over 24.9°C to 33.1°C in direct correlation with solar radiation (Figure 7).

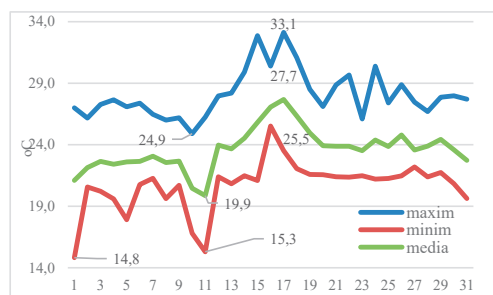


Figure 7. Minimum, maximum and average temperatures recorded daily in the greenhouse in January

In February, during a 24-hour day, average daily temperatures were recorded, between 22°C around 1 AM and 26.3°C around 6 PM. Also, during the day the temperatures reached average values of 17.02°C to 23.3°C and maximums of 32.98°C (Figure 8; Table 1).

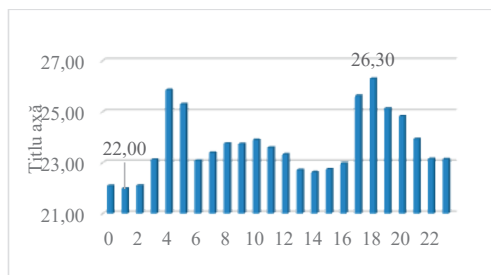


Figure 8. Average daily temperatures recorded in February 2021

Table 1. Average, minimum and maximum monthly temperatures recorded during 24 hours as well as the sum of temperatures recorded in February

Hour	The monthly average temperature degrees (°C)	Minimum temperature (°C)	Maximum temperature (°C)	The sum of the temperature degrees (°C)
0	22,10	18,72	26,86	640,85
1	<b>22,00</b>	17,32	26,84	636,89
2	22,11	<b>17,02</b>	26,7	639,14
3	23,13	20,2	27,08	647,61
4	25,86	23,3	28,39	724,13
5	25,30	20,38	27,68	708,46
6	23,09	20,99	25,9	646,45
7	23,39	20,5	29,25	654,97
8	23,77	21,22	32,28	665,42
9	23,75	20,24	<b>32,98</b>	664,95
10	23,90	20,41	33,5	669,17
11	23,59	19,87	31,77	660,63
12	23,34	20,98	27,33	653,38
13	22,72	19,95	26,65	636,18
14	22,63	20,08	25,12	633,77
15	22,75	20,6	25,78	637,07
16	22,98	19,55	25,85	643,36
17	25,63	17,93	C	717,74
<b>18</b>	<b>26,30</b>	20,13	31,4	736,31
19	25,13	22,97	28,02	703,76
20	24,83	21,88	28,72	695,21
21	23,94	21,16	28,2	670,29
22	23,16	20,32	27,62	648,34
23	23,14	20,29	27,2	647,87

We can remark that for the analysed period we found that the maximum temperatures recorded in the greenhouse reached values of 32.9°C in January, 33.5°C in February and 37.25°C in March. Very high values correlate with high values of external light intensity. Taking into account the optimal values regarding the requirements of the species, in our case tomatoes, were affected the physiological processes of the species determining to the acceleration of fruit ripening and stopping vegetative growth (Table 2).

Regarding the average daily temperatures recorded during January-March, we found that, in January, the temperatures varied between 19.9°C and 27.7°C, in February between 21.88°C and 26.29°C. If we compare with the average recommended temperatures for vegetative growth of 20.5°C (23°C during the day and 18°C at night) and 21°C for fruiting (24°C during the day and 18°C at night), we noticed that very high temperatures influenced the production of fruits but also the duration up to until their ripening, shortening it (Figure 9).

Table 2. Maximum temperatures recorded in January, February and March

Day	January		February		March	
	Max.	Min.	Max.	Min.	Max.	Min.
1	27,0	<b>14,8</b>	27,77	20,51	26,87	21,0
2	26,2	20,6	27,68	21,01	26,0	21,09
3	27,3	20,2	27,6	21,91	25,54	20,59
4	27,7	19,6	29,37	22	26,23	21,62
5	27,1	17,9	29,35	21,4	<b>37,25</b>	22,32
6	27,4	20,8	27,78	20,73	27,59	17,19
7	26,5	21,3	25,58	19,9	24,3	18,53
8	26,0	19,6	28,18	20,8	24,58	19,8
9	26,2	20,7	31,4	21,98	24,99	19,52
10	24,9	16,8	30,98	21,79	24,62	13,2
11	26,2	15,3	29,76	22,64	24,6	<b>13,7</b>
12	28,0	21,4	26,63	20,28	32,73	18,9
13	28,2	20,8	<b>33,5</b>	22,05	24,71	19,92
14	29,9	21,5	27,4	20,94	27,02	20,35
15	<b>32,9</b>	21,1	27,02	22,23	25,37	17,86
16	30,4	25,5	29,9	21,92	26,91	21,78
17	33,1	23,5	29,25	20,24	27,18	20,73
18	31,1	22,1	25,9	19,87	25,62	20,24
19	28,5	21,6	27,12	19,95	25,41	19,98
20	27,1	21,6	27,7	20,29	24,13	19,05
21	28,9	21,4	25,41	20,42	23,2	16
22	29,7	21,4	24,79	20,99	23,96	13,31
23	26,1	21,5	25,38	17,93	24,13	19,46
24	30,4	21,2	25,17	20,41	23,7	18,3
25	27,4	21,3	27,5	20,42	24,51	20,6
26	28,9	21,5	28,72	<b>17,02</b>		
27	27,5	22,2	27,88	20,08		
28	26,7	21,4	26,58	21,98		
29	27,9	21,7				
30	28,0	20,8				
31	27,7	19,6				

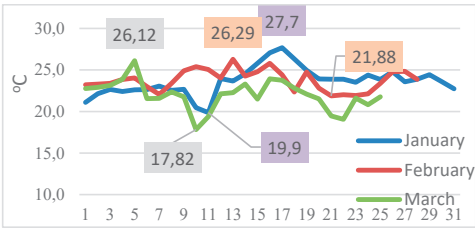


Figure 9. Average daily temperatures for January and February

Another factor that influences plant biology is atmospheric humidity. In the case of growing tomatoes in the greenhouse, we found that the atmospheric humidity in the growing space varied during the day, which was correlated with light intensity and temperature values. It ranged from 35% to 87% in January, from 30% to 78% in February and from 25 to 80% in March. In the first part of the day, in the morning, higher values were recorded (Figures 10-12).

Table 3. Difference between maximum and minimum temperature

Day	Month		
	January	February	March
	°C	°C	°C
1	<b>12,18</b>	7,26	5,87
2	5,6	6,67	4,91
3	7,05	5,69	4,95
4	8,05	7,37	4,61
5	9,17	7,95	<b>14,93</b>
6	6,62	7,05	10,4
7	5,2	5,68	5,77
8	6,38	7,38	4,78
9	5,49	9,42	5,47
10	8,1	9,19	11,42
11	10,94	7,12	10,9
12	6,57	6,35	13,83
13	7,37	<b>11,45</b>	4,79
14	8,42	6,46	6,67
15	11,77	4,79	7,51
16	4,87	7,98	5,13
17	9,61	9,01	6,45
18	9,02	6,03	5,38
19	6,92	7,17	5,43
20	5,54	7,41	5,08
21	7,46	4,99	7,2
22	8,31	3,8	10,65
23	<b>4,62</b>	7,45	4,67
24	9,17	4,76	5,4
25	6,14	7,08	<b>3,91</b>
26	7,41	11,7	
27	5,26	7,8	
28	5,3	<b>4,6</b>	
29	6,12		
30	7,14		
31	8,07		
Media	7,42	7,13	7,04

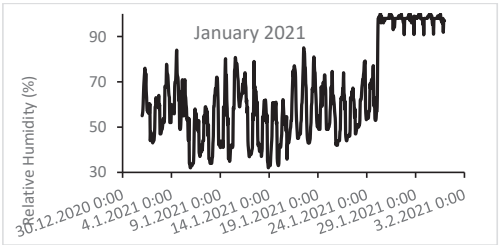


Figure 10. Relative humidity in January

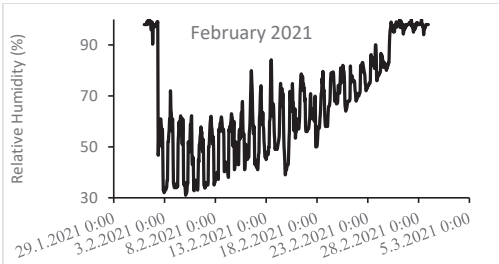


Figure 11. Relative humidity in February



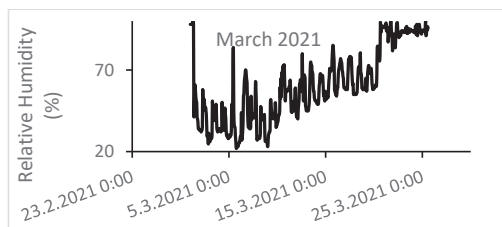


Figure 12. Relative humidity in March

Regarding CO<sub>2</sub>, its beneficial effect is known. Inside the greenhouse, in January, we found minimum values of 120.38 ppm and 1250.31 ppm in the morning, but in general the CO<sub>2</sub> concentration was around 400 ppm (Figure 13).

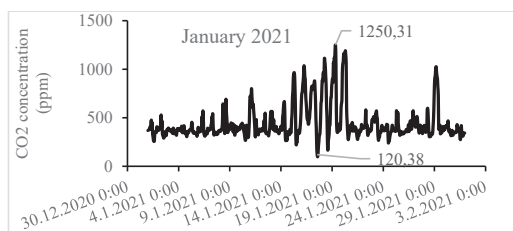


Figure 13. CO<sub>2</sub> concentration in greenhouses in January

In February, CO<sub>2</sub> values ranged from 187.45 ppm to 1186.38 ppm (morning). In general, the CO<sub>2</sub> concentration was within the physiological limits for the vegetative growth and fruiting of tomatoes (Figures 14 and 15). In March we found normal values that ranged between 216.52 ppm and 720.06 ppm (morning).

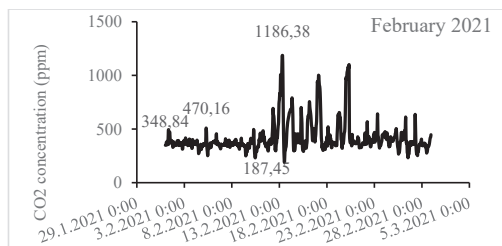


Figure 14. CO<sub>2</sub> concentration in greenhouses I February

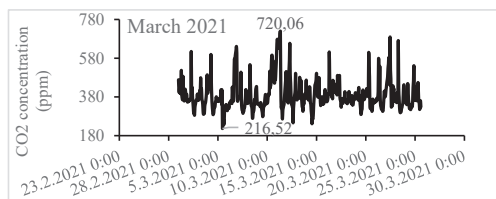


Figure 15. CO<sub>2</sub> concentration in greenhouses in March

If we analyse if there was any relationship between CO<sub>2</sub> values and production and calculating the correlation coefficient we found moderate negative relationships  $R^2 = 0.395$  (Figure 16).

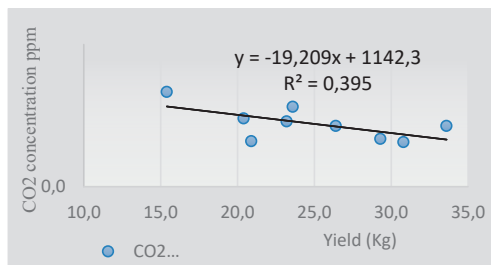


Figure 16. Relationship between the CO<sub>2</sub> content of the greenhouse and the production obtained for the 'Cheramy' variety

However, if we analyse how carbon dioxide influenced production, we could see a negative influence with its increase.

The Person relationship indicates a moderately negative correlation ( $R = -0.629$ ). For the 'Cheramy' variety, the increase in CO<sub>2</sub> content did not show an increase in production (table). If we analyse how carbon dioxide influenced production, we could see a negative influence, as it increases.

The Person relationship indicates a moderately negative correlation ( $R = -0.629$ ).

For the 'Cheramy' variety, the increase in CO<sub>2</sub> content did not show an increase in production (Table 4).

Table 4. Pearson test on the relationships between the total production obtained in the greenhouse of the 'Cheramy' variety, the concentration of CO<sub>2</sub> and the sum of the temperatures accumulated in the greenhouse

Cheramy	Production (kg)	CO <sub>2</sub> concentration (ppm)	Accumulated temperature sum (°C)
Production (kg)	1		
CO <sub>2</sub> concentration (ppm)	-0.629	1	
Accumulated temperature sum (°C)	-0.540	0.033	1

In the ‘Flaviola’ variety there is a weak negative relationship between the CO<sub>2</sub> concentration and the production obtained  $R^2 = 0.1695$  (Figure 17).

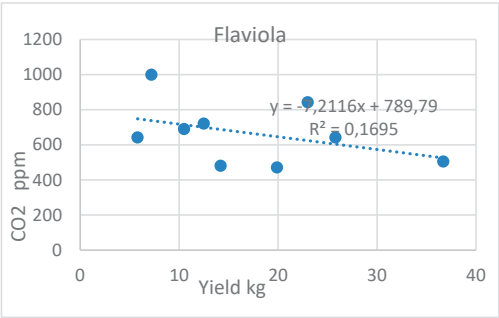


Figure 17. The influence of CO<sub>2</sub> on ‘Flaviola’ production

If we look how much the CO<sub>2</sub> value in the greenhouse influenced, we find that the ‘Flaviola’ variety reacted less to the increase in CO<sub>2</sub> content, the Person relationship indicates a moderately low relationship ( $r = - 4117$ ) (Figure 18).

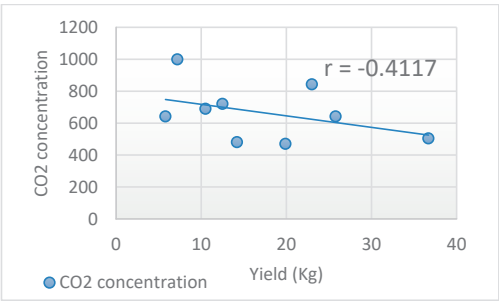


Figure 18. Influence of CO<sub>2</sub> on ‘Flaviola’ production



Figure 19. Aspect of culture

In ‘Cheramy F1’, the correlation made between the productions obtained during the study period and the sum of the temperatures recorded between the harvesting periods indicated a weak positive influence ( $R^2 = 0.2654$ ) between them.

To see how much the temperature influenced the production level by the calculation performed by the Person test we found a high positive relationship  $r = 0.51518$  (Figure 20).

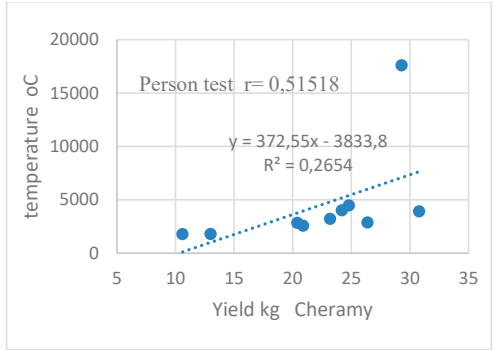


Figure 20. The influence of the accumulated temperature between harvests on the total production obtained for the ‘Cheramy’ variety

The correlation made between the yields obtained and the cumulative sum of the temperatures recorded during the harvest periods indicated a weak positive influence ( $R^2 = 0.0049$ ) between them.

To see how much the temperature influenced the production level, the cumulative sum of the recorded temperatures and by the calculation performed using the Person test we found an insignificant positive relation ( $r = 0.0698$ ) (Figure 21).

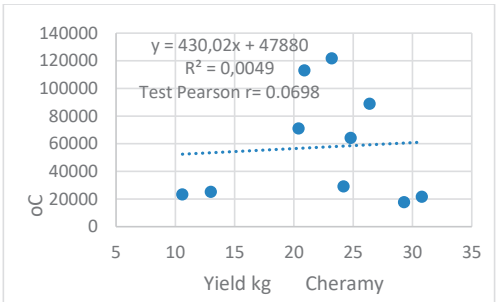


Figure 21. Influence of the sum of the cumulative temperatures between harvests on the production of the ‘Cheramy’ hybrid





Figure 22. Aspect of culture

In the case of the 'Flaviola' variety, we noticed that it reacted to the temperature values recorded between harvests.

The correlation made between the productions obtained on each harvest and the temperatures recorded between harvests had a positive influence ( $R^2 = 0.4081$ ).

To see the extent to which temperature values influenced production we calculated using the Pearson test and obtained a large relationship between them  $r = 0.639$  (Figure 23).

If we analyse the influence of the sum of the temperatures accumulated in the greenhouse between harvests we can see that there is a negative relationship  $R^2 = 0.4736$ .

To see how much it influences this we calculated using the Pearson test and we noticed that the value was negative ( $r = -0.688$ ), the influence being average (figure 24).

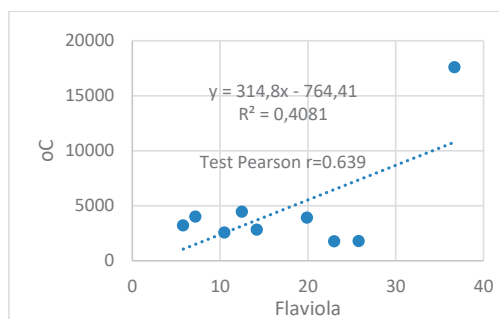


Figure 23. Relationship between yields obtained on 'Flaviola' varieties and the sum of temperatures between harvests

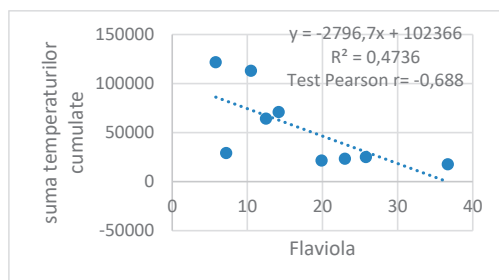


Figure 24. Relationship between yields per harvest and the sum of cumulative temperatures recorded at harvest

Table 5 summarizes the data on the influence of CO<sub>2</sub> and the sum of the cumulative temperatures on production of the 'Flaviola' variety.

Table 5. Influence of CO<sub>2</sub> and sum of temperatures on crops on 'Flaviola' production

Flaviola	Production (kg)	CO <sub>2</sub> concentration	The sum of the accumulated temperatures
Production (kg)	1		
CO <sub>2</sub> concentration	-0.4117	1	
The sum of the accumulated temperatures	-0.741	0.033	1

The number of plants under observation was 154 plants in the 'Cheramy' hybrid and 101 plants in the 'Flaviola' cultivar.

The total fruit production obtained from the plants harvested from the greenhouse was 223.6 kg for 'Cheramy F1' and 155.6 kg for the 'Flaviola' variety (Figure 25).

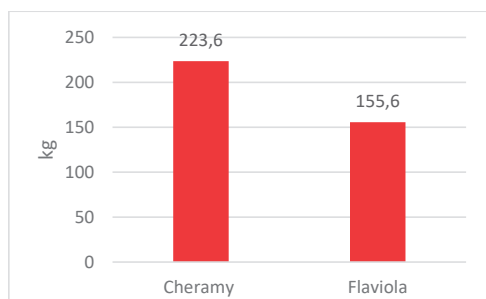


Figure 25. Total production of tomatoes obtained in the greenhouse

If we follow the relation regarding the production obtained between the analysed varieties, we found positive relations between them  $R^2 = 0.4031$  but the Pearson test clearly shows that the variety reacts differently to the temperature conditions, the influence being significant (Pearson test  $r = 0.6635$ ) (Figure 26). The influence of cumulative temperatures had a significant influence (Figure 27).

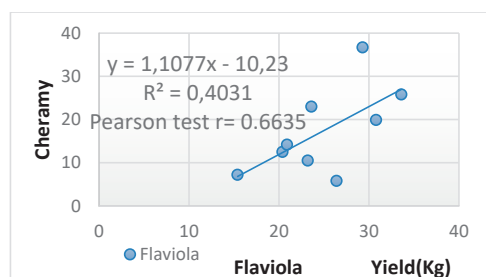


Figure 26. The interaction between the yields obtained for the analysed variety

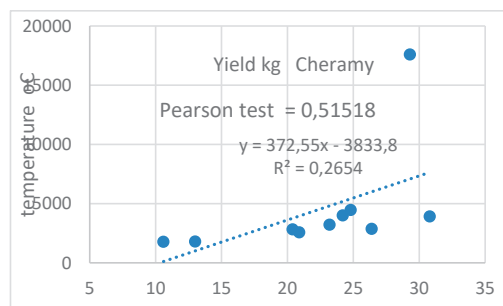
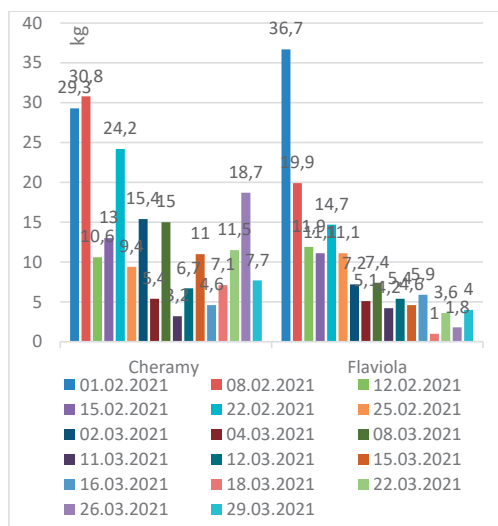


Figure 27. Influence of cumulative temperatures on production of 'Cheramy F1'

At the first harvest on 1.02.2021, 36.7 kg were obtained from the 'Flaviola' variety and 29.3 kg from the 'Cheramy' variety (Figure 28).



Figures 28. Harvests performed on the analysed cultivars



Figure 29. Aspect of culture - 'Flaviola'

The average production obtained per plant was in the case of the 'Flaviola' variety of 1.5406 kg/plant and in the case of the 'Cheramy' hybrid of 1.4519 kg/plant (Figures 29 and 30).

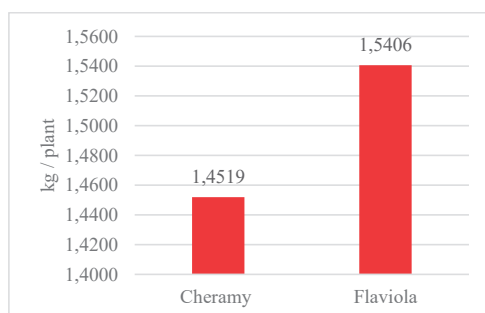


Figure 30. The average yield per plant of the 'Cheramy' and 'Flaviola' varieties

The productions of tomatoes were performed weekly and recorded. Thus, we found that they were higher in the ‘Flaviola’ variety compared to the ‘Cheramy’ hybrid. One conclusion would be that the ‘Cheramy’ hybrid is influenced by variations in the temperature and light factor (Figure 31).

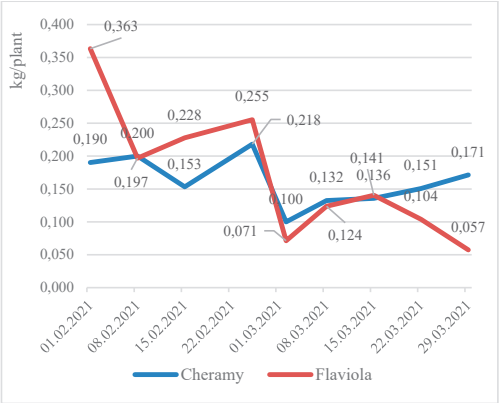


Figure 31. Average weekly harvest on plant

During the care works, we periodically carried out works to remove the leaves on the plant. The first deforestation was carried out after 20 days, and the rest of the deforestation of the vegetative mass of the leaves was made done as many times as needed. The figure shows the dates and the number of days after which the leaves were removed (Figure 32).

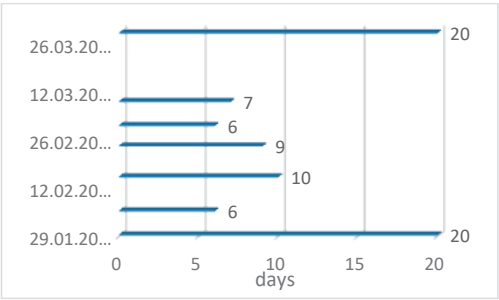


Figure 32. Number of days between leaf harvests

All vegetative mass was recorded. We found that, at the first and second harvest, the highest amount of vegetative mass was recorded for the ‘Flaviola’ variety of 11.7 kg at the first harvest and 10.6 kg at the second harvest. In this variety the vegetative mass harvested in the following stages was lower compared to the ‘Cheramy’ hybrid (Figure 33).

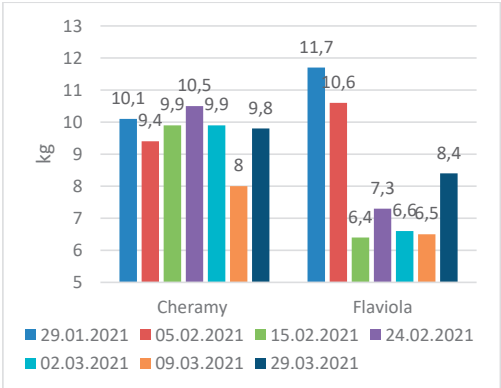


Figure 33. The total amount of leaves harvested in the greenhouse

In the case of the ‘Cheramy’ hybrid, a total of 67.6 kg was harvested per plant, with an average per plant of 0.439 kg, and for the ‘Flaviola’ variety, 57.5 kg, with an average per plant of 0.569 kg (Figure 34).

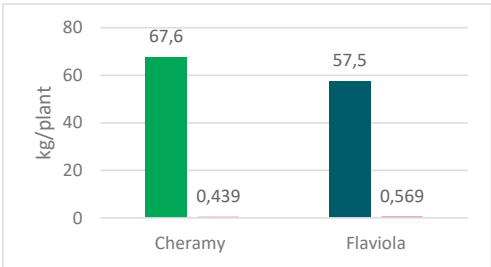


Figure 34. Total amount of leaves harvested at the analyzed cultivars and the average per plant

Analysing the relationship between the analysed varieties and the mass of harvested leaves in stages, we found that between varieties, the influence was small ( $R^2 = 0.0453$ ), but the Pearson relationship shows that there was a weak positive relationship between the two varieties and leaf production ( $r = 0.213$ ) (Figure 35 and Table 6).

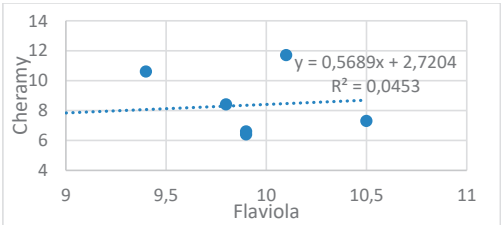


Figure 35. Influence of varieties on total leaf production

Table 6. The correlation between the two varieties on leaf production

Total mass Leaves	Cheramy	Flaviola
Cheramy	1	
Flaviola	0.213	1

Analysing the total accumulated vegetative mass, for each variety, we found that at the ‘Cheramy’ hybrid a quantity of 184.8 kg was obtained and for the ‘Flaviola’ variety 141.4 kg vegetative mass. On average, 1.2 kg/plant at ‘Cheramy’ hybrid and 1.4 kg/plant at ‘Flaviola’ variety were obtained (Table 7).

Table 7. Total vegetative mass harvested (leaves and stems)

Specification	UM	Cheramy	Flaviola
Total vegetative mass	kg	184.8	141.4
Total plants	No.	154	101
Average mass / plant	kg/plant	1.2	1.4

Table 8. Total vegetative mass and total fruit harvested on plant in the ‘Cheramy’ hybrid

Total vegetative mass and fruits	Vegetative mass	Total fruit mass
kg	kg	kg
408.4	184.8	223.6

In ‘Cheramy F1’, the percentage of harvested fruit represented 54.75% of the total accumulated vegetative mass, and the mass of leaves and stems 45.25% (Figure 36).

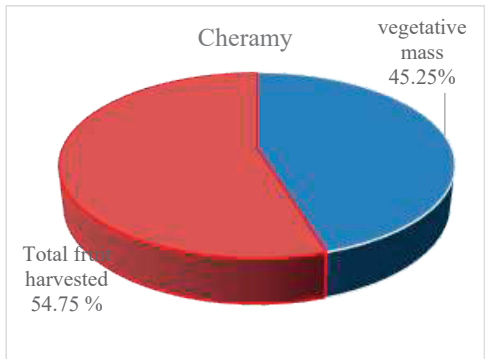


Figure 36 Percentage of vegetative mass and fruit yield in the ‘Cheramy’ hybrid

In the Flaviola variety, in the analyzed period, the percentage of fruits harvested on average

per plant was 60.64%, and that of leaves and stems 39.36% (Figure 37).

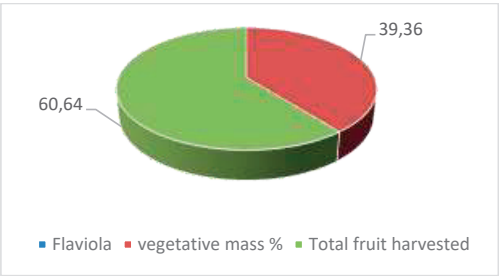


Figure 37. Percentage of vegetative mass and fruit yield in the ‘Flaviola’ hybrid

## CONCLUSIONS

Analysing the temperatures recorded in the greenhouse during the period of vegetation and fruiting of tomatoes, we could see that its values were higher in February and March, which led to the acceleration of fruit ripening. In the ‘Flaviola’ variety, the temperature had a greater influence on the production compared to the ‘Cheramy’ variety. We noticed that each variety reacted differently both in terms of temperature and CO<sub>2</sub> values. The accumulated vegetative mass was higher in ‘Cheramy F1’ compared to ‘Flaviola’, this being a genetic characteristic of the cultivar. The percentage of fruits obtained per plant was 54.75% and only 45.25% vegetative mass in ‘Cheramy F1’. For the ‘Flaviola’ variety, the percentage of fruits was 60.64% and 39.36% vegetative mass.

## ACKNOWLEDGEMENTS

This research work was carried out with the research leading to these results has funding from the Norway Grants 2014, under Project contract no. 40/2021

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