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PRODUCTION OF CHERRY TOMATOES FERTIGATED UNDER DIFFERENT TYPES OF ORGANIC SUBSTRATES IN THE MUNICIPALITY OF BREVES, MARAJÓ ISLAND – PA

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ABSTRACT
There are many factors that directly affect tomato production, even making the crop unfeasible in some regions of Brazil. Thus, the research aimed to evaluate the fertigated production of cherry tomatoes under different types of organic substrates. The research was carried out in a greenhouse with microclimatic monitoring with the crop (cv. sweet grape) being produced in 8l pots conducted on a single stem, under cultivation different levels and types of organic substrates, being fertigated automatically via sphaguet. The results showed that the vegetative growth of the plants suffered little interference from the treatments and microclimatic conditions, but the production was drastically impaired by the microclimatic inclement weather. Thus, it is concluded that the cultivation of cherry tomatoes can be carried out in the Marajó region with decomposing wood sawdust (mill) replacing the traditional coconut fiber.

Keywords: Greenhouse. Sawdust. Coconut Fiber. North Region.

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INTRODUCTION

Among fruit vegetables, tomatoes have become the most important vegetable in the world. Currently, it ranks first in value and volume of production in Brazil (Ibge, 2015). According to the source, Brazil's tomato production in 2023 was approximately 4.167 million tons, with an average productivity of 70.6 kg per hectare, being the eighth largest producer in the world according to the Food and Agriculture Organization (FAO, 2023). Considering the national panorama, Goiás is the largest producing state, with an area of 13,234 ha and production of 1.028 million tons (t $^{ha-1}$), followed by São Paulo with an area of 11,983.0 ha and 1,039.69 tons (t $^{ha-1}$) and Minas Gerais with an area of 7,485.0 ha and production of 561,810.0 tons (Ibge, 2023). These data portray the production of common tomatoes, used for the most varied forms in the direct selling industry, produced basically in the open field. However, smaller and tastier than regular tomatoes, cherry tomatoes have lately been falling in the taste of Brazilian consumers (Cantelli, 2018; Rosa and Reis, 2022). According to the authors, in addition to its flavor, its production is linked to the added value that the cherry variety has in relation to the common tomato, with a much higher price paid to the producer. Aiming at this added value, many producers have been investing high amounts in specialized structures in order to enable constant production and meet the quality requirements of the market. Among these structures are technologies in a protected environment, fertigation and substrates, however, many producers use simple production systems with low use of technologies and are achieving good production results and market quality (Araujo *et al*, 2016). Thus, in order to reduce production costs, improving or maintaining production and market quality, research with the use of alternative substrates can be decisive, since they represent a significant portion of production costs, especially in the northern region of Brazil, due to the low demand for this product in the state. The production of table tomatoes in a protected environment is conditioned to the use of fertigation and substrate based on coconut fiber, which have so far the best characteristics in terms of moisture retention and root development according to the literature. However, this type of substrate, in addition to increasing production costs (Sena *et al.,* 2023), occupies a considerable volume for its transport to the places of use. In the city of Breves, the product does not exist in the market due to lack of demand, and on the internet, price research showed that the 107-liter bag of coconut fiber costs an average of R$ 661.63 for delivery in the city (Mercado Livre, 2024). In view of the high values for the acquisition of the input, it is unfeasible to recommend the implementation of the crop to the

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producers of the municipality, who in their vast majority do not have the financial resources necessary for the high investment, even though it is an easy-to-manage, but laborious, fast and high economic return crop. Allied to this fact, and in the need to enable the implementation of some crops with quick economic return in the municipality, especially for family farming, it is necessary to conduct research in this sense in *locu* capable of showing the agricultural community alternatives to make its production feasible with low allocation of resources a priori.

Due to the low purchasing power, this form of agriculture makes use of several inputs available in abundance in the region. However, it is necessary to study and validate the use of these alternative inputs through research to foster this form of , which would certainly help to family farming. Such materials, until now, have contributed to the pollution of the environment, since the vast majority are discarded inappropriately and not used in agriculture due to their slow decomposition under natural conditions. In this regard, the Marajó Archipelago is one of the richest regions of the country in terms of water and biological resources, defined and geographically organized from the characteristic natural aspects of its agroecosystem. Such characteristics end up fostering the vegetable extraction of Amazonian fruits, especially açaí, which has been gaining prominence every day in the national and international market. However, the extraction of fruit pulp generates a large amount of waste, on average 90% (Petruz, 2024), for which there is still no adequate destination in the producing cities, being most of the time improperly incorporated into urban dumps. In addition to the açaí seed, another abundant waste in the region is the dust of sawn wood, known locally as "mill", which, unlike the previous waste, ends up being used as a form of "landfill" for flooded land in cities, which would also not be an adequate destination. According to the National Solid Waste Policy, Law No. 12,305/2010, waste must have an environmentally appropriate destination, and may go through the process of recycling, composting, recovery, energy use or other necessary destinations, so as to avoid damage or risks to public health and safety, in addition to minimizing adverse environmental impacts (Brasil, 2012). Almeida *et. al.* (2019) found that the use of substrate for plants produced from the residue generated in the production of açaí pulp presents itself as a viable solution to environmental problems related to the açaí production chain, since with the use of the substrate the life cycle of this chain is closed. The authors showed that there are good nutritional results of the substrate from the açaí seed, however, its use as a substrate for tomato production has not yet been researched, so there is no scientific information on the possibility of its use for fertigation crop production. The nutrition existing in the substrate from the açaí seed verified by Almeida *et. al.* (2019) can favor the reduction of fertigation applied to the crop, and thus reduce the production costs involved, this type of fertilization being called organomineral (Oliveira *et al.,* 2023). Thus, this research is justified by the high amount of waste in the localities that make use of açaí pulp, since the research proposes to give an adequate destination to this abundant by-product, through its use as an alternative substrate for the production of cherry tomatoes in family farming properties. Therefore, this research aimed to evaluate the fertigated production of cherry tomatoes under different types of organic substrates, in order to find an alternative substrate to the use of coconut fiber for cherry tomato production.

METHODOLOGY

The research was developed in the Experimental Field of the IFPA *Breves campus*, Marajó region, in a greenhouse with North-South orientation, with a total area of 216 m2 (09 x 24 m) and 3.0 m of ceiling height, built in sawn wood. The gable roof (London type with 0.15 m lantern) is covered with 100 micron low-density polyethylene plastic and has closed sides up to 2.40 m, bottom to top, with 50 mesh anti-aphid mesh (Baby Citrus). The microclimatic characterization of this greenhouse was carried out by a portable temperature and relative humidity sensor (thermo-hygrometer) with data acquisition system (TempU 03, accuracy ±1°C and ±3%), positioned and monitored at the height of the plant canopy, duly allocated in a meteorological shelter made of Styrofoam and covered with aluminum foil to protect from the direct incidence of solar radiation, being programmed for data acquisition every 15 minutes. The tomato cultivar of the minitomato group, hybrid variety SWEET GRAPE (reproduced from commercial fruits) (Sakata company), indeterminate growth habit, fruits with an average weight of 15 g and harvest ranging from 90 to 100 days after sowing were used. On 03/21/2024, the treatments were prepared, which are based on five types of substrates: coconut fiber, naturally decomposed açaí seed, crushed decomposed açaí seed, wood sawdust and sand, allocated in pots with a volume of 8.0 liters (height of 0.22 m and diameter of 0.20 m and mouth of 0.28 m), these being duly identified, mixed and allocated totally at random. The rows of the pots were arranged in two straight rows with spacing of 0.40 m between plants and 0.82 m between rows, with each pot being placed on bricks in order to keep them without direct contact with

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the soil. These planting rows were irrigated by a commercial sphaguet type drip irrigation system using two sphaguets (0.50 m each) per pot (average flow rate of 3.6 l/h. This system was activated by a timer previously programmed to turn on and off at first (up to 40 days after transplanting - DAP) with a washing machine pump connected in series to a solenoid valve, and these coupled to a 1,000-liter water tank. After this period, due to many clogging events caused, mainly by the precipitation of iron present in the water and its high temperature, this pump was replaced by a 1/4 hp Scheider pump, remaining until the end of the crop cycle. The timer followed the following schedule: from 1 to 30 DAP - 7:00 am – 02 min, 08:30 am – 03 min, 10:0 am – 05 min, 11:30 am – 07 min, 1:00 pm - 9 pm, 2:30 pm – 9 min, 4:00 pm – 7 min, 5:30 pm – 5 pm from 31 to 60 DAP these irrigation times were doubled, maintaining the same schedules, and from 60 DAP the same tripled The volume applied to the vessels (Treatments) was monitored, quantifying the leachate at the end of the day in at least one vessel of each treatment, taking care to always leave a leaching rate of at least 20% of the volume applied, taking the treatment with the lowest leaching as a base. For transplanting, seedlings were produced in a nursery in Styrofoam trays composed of 200 cells, with a commercial substrate based on coconut fiber, rice husks, vermiculite and carbonized group, sown on January 3, 2024, and irrigated four times a day. From the 7th day on, the seeds began germination, and manual fertigation began from the 14th day, and this fertiirrigation was carried out every two days with nutrient solution at EC of 0.4 to 0.6 mS/cm of conductivity with balanced nutrients (nutriplan commercial product – tomato 1 and 2). On 02/22/2024, the seedlings were transplanted into tubes with a volume of 120 ml, with the purpose of developing before transplanting to the pots. On 03/22/2024 the seedlings of the "mudan" type were transplanted to the pots definitively. The plants were conducted on a single stem with removal of the lateral shoots weekly and manual pollination at least twice a day (Morning and Afternoon), staked with ribbon and wire on the espalier at 2.20 height, with the nutrition diluted in the irrigation water (fertigation), and this used as a commercial product (NUTRIPLAN – Tomato 1 and 2), balanced for all phases of the crop. Thus, the electrical conductivity was varied according to the development of the crop and the manufacturer's recommendation, being 1.20 mS/cm in the vegetative phase and 1.50 mS/cm in the development phase and 2.00 mS/cm in the fruiting and production phase, and this control was carried out with a portable conductivity meter. During the conduction, the climatic data of the greenhouse and the crop were collected, and meteorological data of temperature and relative humidity of the air at

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variable height were collected from the greenhouse, following the canopy of the plants in production. The variables related to the crop were measured after transplanting, lasting at average intervals of seven days until apical pruning, and the following variables were analyzed: plant growth that was included in the determination of the height and diameter of the plant stem. In addition to the production components, which took place from the point of harvest of the fruits, characterized by the change from green to completely red color, the number of fruits per plant and per seed, average fruit mass, total and commercial productivity (kg $^{m-2}$) of all plants of their respective treatments were counted.

For statistical analysis of the treatments, the experimental design Completely Randomized was used, with 15 treatments and 4 replications: T1 - Vase with 100% sand; T2 – Vase with 100% decomposed mill; T3 – Vase with 100% crushed decomposed açaí seed; T4 – Vase with 100% coconut fiber; T5 – Pot with 50% sand and 50% decomposed mill; T6 – Pot with 50% sand and 50% decomposed açaí seed; T7 – Pot with 50% sand and 50% crushed decomposed açaí seed; T8 - Pot with 50% decomposed açaí seeds and 50% decomposed mills; T9 - Pot with 50% decomposed açaí seeds and 50% crushed decomposed açaí seeds; T10 - Pot with 50% crushed decomposed açaí seeds and 50% decomposed mill; T11 - Vase with 50% sand and 50% coconut fiber; T12 - Pot with 50% coconut fiber and 50% açaí seed; T13 - Pot with 50% coconut fiber and 50% crushed decomposed açaí seed; T14 - Pot with 50% coconut fiber and 50% decomposed mill; T15 – Pot with 25% coconut fiber, decomposed mill, decomposed açaí seed and crushed decomposed açaí seed. The data were submitted to analysis of variance and comparison between the means was performed by Tukey's test.

RESULTS AND DISCUSSIONS

Analyzing the temperature and average relative humidity of the air inside the greenhouse during the research period (1st data download – 03/18 to 05/06, 2024), it was found that they were 29.3 ºC and 87.80% respectively, demonstrating high temperature and high humidity inside the greenhouse during this period (Figure 1), and maximum and minimum rates of 45/24°C and 49.4/100%, respectively.

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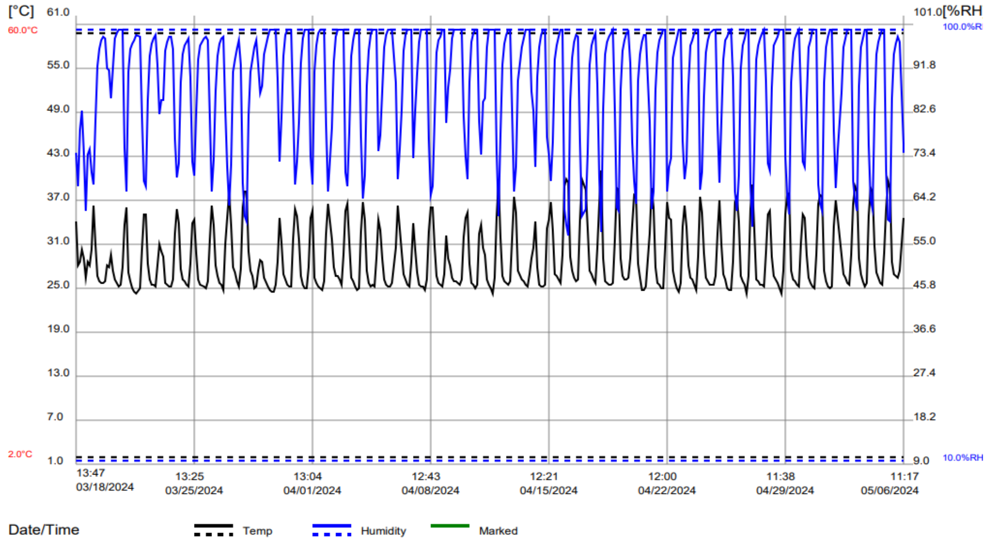
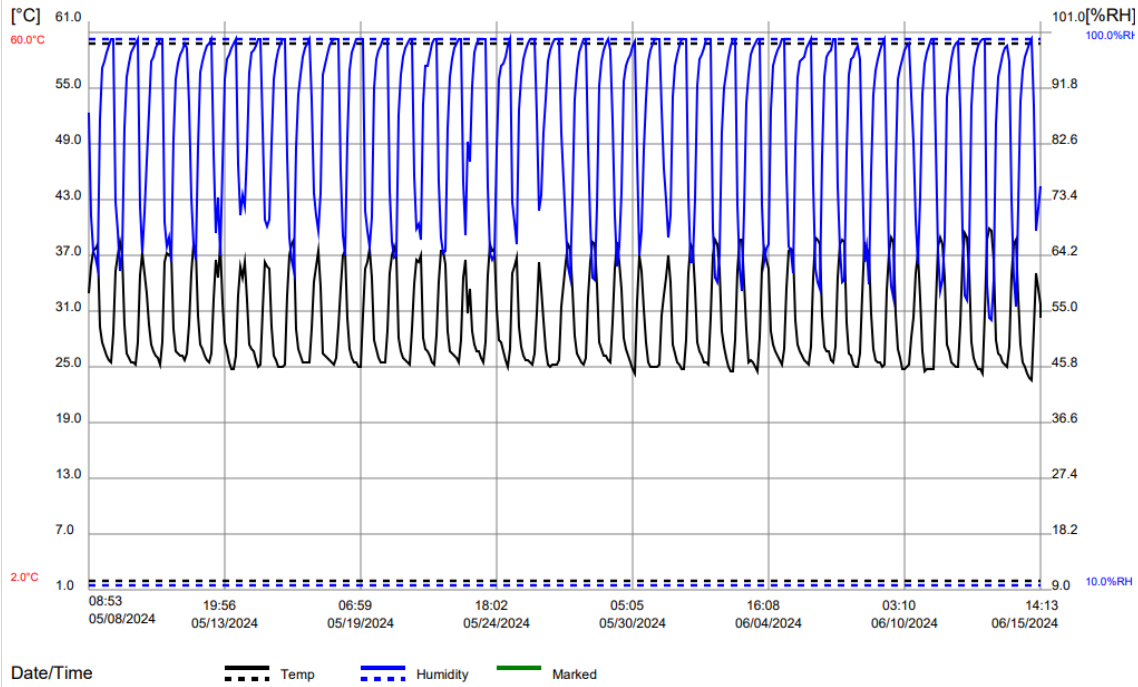
Figure 1 - Graph of the daily average temperature and relative humidity of the air inside the greenhouse - collection 1.



During the second data collection (05/08 to 06/15, 2024), it was found that the values of temperature and relative humidity were 31.1 ºC and 85.90%, respectively, demonstrating that in this period the temperature was even higher when compared to the previous measurement, with a slight reduction in relative humidity, but still considered high for the tomato crop (Figure 2). The maximum and minimum observed in the period were 41.2/23.6°C for temperature and 51.8/100% for air humidity.

Figure 2 - Graph of the daily average of temperature and relative humidity of the air inside the greenhouse - collection 2.



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According to YaraNutre (2024), to ensure profitable tomato production, the ideal temperature for tomato cultivation varies between 18°C and 27°C, and temperatures above 35°C can affect the fixation of the fruits and their color. Campagnol *et al*. (2016), report that temperature is the environmental factor with the greatest influence on the different stages of crop growth, with ideal thermal variations between 27 ± 4 °C during the day and 18 ± 2 ºC at night. The authors state that to maximize fruit set, the optimal daytime temperature range is 19 to 24 °C, and the night temperature is 14 to 17 °C. Comparing the microclimatic data collected during the conduct of the research with the climatic requirements for the crop, it is observed that the climatic conditions drastically affected the production of the crop in the region.

Table 1 shows the ANOVA of the vegetative growth data of the plants throughout the samplings carried out (over time). In this study, it is possible to observe that only two samples presented statistical differences. Thus, sample 2 was statistically different at the level of 1% for plant height and stem diameter. Sample 10 was statistically different at a level of 5% only for plant height. This shows the little interference of the different substrates on the variables analyzed in a fertigation production system in the region.

Table 1 - Analysis of variance of plant growth data.

Amost.	Source of Variation	Height of plants	Stem Diameter
		F	
1 – 7 DAT	Treatments	1,4579 ns	1,1643 ns
CV (%)		13,93	16,11
2 – 14 THAT		7,4488 **	6,4676 **
CV (%)		14,33	15,34
3		1,4579 ns	1,1643 ns
CV (%)		13,93	16,11
4 – 28 THAT		1,4414 ns	0,6142 ns
CV (%)		12,83	15,59
5 – 30 THAT		1,4549 ns	1,4414 ns
CV (%)		13,63	12,83
6 – 42 THAT		1,3556 ns	0,7863 ns
CV (%)		14,22	16,11
7 – 49 THAT		0,9354 ns	1,0782 ns
CV (%)		14,68	16,85
8 – 56 THAT		1.3169 ns	1,2035 ns
CV (%)		12,52	16,16
9 – 63 THAT		1,3829 ns	1,2331 ns
CV (%)		11,22	15,38

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10 – 70 THAT		2,0538 *	1,3837 ns
CV (%)		9,15	14,4

DAT: Days after transplantation; CV: coefficient of variation; Ns: not significant; *: significant at the level of 5%; **: significant at the level of 1% probability respectively

In the comparison of the means for the samples that presented statistical significance, Table 2, it was possible to observe that the best treatment, both for the growth and for the diameter of the plants among the types of substrates used, was with the use of a pot with 100% sawdust (mill) in decomposition, but no difference with the treatment with 100% sand. Although it was only a sampling, it was a good indication of an excellent result, since it is an easily available and free substrate in the region, to the detriment of sand, which is sold.

Table 2 - Comparison of the means for the significant treatments in the different samples.

Sampling	Treatments	Height of plants (m)	Stem diameter (mm)
2 – 14 DAT	1	0.81500 from	6.62500 from
	2	0,95250 a	6,75000 a
	3	0,73500 abc	6,30000 abc
	4	0,60500 bcd	3,97500 D
	5	0,53750 cd	4,90000 abcd
	6	0,56500 cd	4,82500 bcd
	7	0.50250 d	4,47500 cd
	8	0,64250 bcd	5,05000 abcd
	9	0,58000 cd	3,90000 D
	10	0,62250 bcd	4,62500 cd
	11	0,54500 cd	4,62500 cd
	12	0,64000 bcd	4,07500 d
	13	0,52250 cd	4,40000 D
	14	0,53250 cd	4,40000 D
	15	0,60500 bcd	3,97500 D
10 – 70 DAT	1	2,37 a	6,45 a
	2	2,26 a	6,05 a
	3	2,34 a	5,62 a
	4	2,52 a	5,95 a
	5	2,47 a	5,32 a
	6	2,33 a	5,8 a
	7	2,83 a	6,45 a
	8	2,48 a	5,62 a
	9	2,40 a	4,8 a
	10	2,62a	5,72 a
	11	2,65 a	5,8 a
	12	2,67 a	5,97 a
	13	2,49 a	4,77 a
	14	2,28 a	5,8 a
	15	2,58 a	5,5 a
Total Averages		2,48	5,708

Consecutive means of the same letter in the same column do not differ statistically by Tukey's test (p<0.05). T1 - Vase with 100% sand; T2 – Vase with 100% mill; T3 – Vase with 100% crushed açaí seed; T4 – Vase with 100% coconut fiber; T5 – Vase with 50% sand and 50% mill; T6 – Vase with 50% sand and 50% açaí seed; T7 – Pot with 50% sand and 50% crushed açaí seed; T8 - Pot with 50% açaí seeds and 50% grind; T9

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- Pot with 50% açaí seeds and 50% crushed açaí seeds; T10 - Pot with 50% crushed açaí seeds and 50% grind; T11 - Vase with 50% sand and 50% coconut fiber; T12 - Pot with 50% coconut fiber and 50% açaí seed; T13 - Pot with 50% coconut fiber and 50% crushed açaí seed; T14 - Pot with 50% coconut fiber and 50% mill; T15 – Pot with 25% coconut fiber, mill, stone.

In the second sample in which there was a statistical difference, i.e., in sample 10, it was observed that even with the ANOVA (Table 1) showing significance at the level of 5%, Tukey's test for comparing the means for sample 10 did not present a significant difference between the treatments, possibly due to the proximity of the minimum significant difference (DMS). The literature portrays this observation as a false positive verified in ANOVA and attributed to statistical errors already predicted, although this significance can be observed in another mean comparison test. However, in the three months of conducting the crop in the field, it reached 2.48m in height and 5.70 mm in diameter at the height of the neck, presenting a good vegetative and reproductive development in terms of flowering. Sena *et al.* (2023), in fertigated cultivation of saladete tomatoes of determined growth in the State of Amazonas, found average values of plant height of 1.0225 m and diameter of 8.9 mm, values that are very different from those found in this research, due to the cultivar and growth habit among the cultivars used in the research, different from those of the present study. However, good vegetative development was obtained in the region, corroborating the results verified in this research.

When analyzing the productivity and the other production parameters, it was found that the treatments did not present any statistical difference between them (Table 3), which may be related to the high coefficient of variation, which presented values above 87%, indicating a high discrepancy between the data collected in the treatments. This discrepancy may be related to the lack of data in some replications between treatments, caused by low fruit set.

Table 3 – Analysis of variance of production data.

Source of Variation	GL	Fruit diameter (mm)	Fruit length (cm)	Number of fruits per plant	Productivity (Kg/m2)	Average Weight (g)
		F				
Treatments	14	0,6505 ns	0,7079 ns	0,5803 ns	0,5219 ns	0,8166 ns
Waste	45					
CV (%)		87,43	93,95	151,76	161,55	94,66

Coefficient of variation; Ns: not significant; *: significant at the level of 5%; **: significant at the level of 1% probability respectively

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As the productive data did not present statistical differentiation between the treatments, only the means were presented in Table 4. There it is observed that the production of cherry tomatoes in the region is much lower than that achieved in other regions of the country. These data are corroborated by Sena a *et al.* (2023), although for another group of cultivars. Ferreira *et al.* (2017), with regard to productivity, number of fruits and fresh fruit mass, were also unable to verify a significant effect between the treatments used. Silva *et al.* (2020) recorded production above 2 kg per plot for the evaluation of different cherry tomato cultivars in pots under the conditions of Juazeiro, BA.

Table 4 – Average of the production data.

Treatments	Fruit diameter (mm)	Fruit length (cm)	Fruits by plant	Productivity (g/m2)	Average weight per fruit (g)
Medium	5,82	8,53	5,05	56,89	6,95

This low yield may be related to the strong interference of the microclimatic parameters recorded in the production environment as shown in figures 1 and 2, because the on-site production registered good levels of flowers, despite high abortion of them, without fruit set, which significantly affected the production, and repetitions were recorded without productive data. This interference is proven by Campagnol *et al.* (2016), which reports that high temperatures cause several problems, including fruiting, because the development of the ovule and the mobility of the pollen grains become slow, causing the abortion of flower buds. For Conceição and Souza (2021), a solution to mitigate problems with high temperatures is to use Aluminet® thermoreflective screens, which, in addition to thermal control, promote high diffusion of sunlight that enters the environment, promoting a temperature reduction of up to 8°C.

CONCLUSIONS

In view of the results, it is concluded that the cultivation of cherry tomatoes can be carried out in the Marajó region with decomposing wood sawdust to replace the traditional coconut fiber, but it is necessary to use aluminets in order to reduce the internal temperature of the greenhouse and thus correct the problems with flower abortion and consequently greater fruit set.

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