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Efficiency of Soil Mulches in Tomato Cultivation Systems

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ABSTRACT

The use of different types of soil cover in tomato culture can influence soil temperature, humidity and plant productivity. However, coverage when associated with cultivation techniques through staking systems can provide better productivity when compared to production systems without coverage and staking. In this sense, the present study aimed to evaluate the effect of different soil coverings on tomato (Lycopersicon esculentum L.), under different staking conditions. The experiment was carried out in the village of Garangau in the municipality of Campo do Brito, Sergipe. To obtain the data, the experiment took place in two stages, with each stage being evaluated four treatments with different soil coverings: biomanta with weight 600 (B600), biomanta with weight 800 (B800), soil raffia (RF) and soil without coverage (SC). It can be seen through the results that the coverings that most influenced the reduction of the soil temperature in the depth to 0.05 m, were the biomanta with weight 600 (B600), biomanta with weight 800 (B800) without staking, respectively, providing a reduction in soil temperature between -3.0ºC to -4.0ºC. It is worth mentioning that similarly, the same results were found at a depth of 0.12 m. This decrease in temperature is related to the effect of the cover and to reduce the incidence of sunlight directly on the soil, thus providing better thermal comfort to the soil. For soil moisture at a depth of 0.15 m and 0.30 m, when comparing the types of cover in the soil raffia soil (RF) without the use of staking technique showed better results. It is believed that it was mainly influenced by the type of driving system. When it comes to productivity, it can be seen that the productivity of tomato per hectare was higher when using the guidance system with tutoring for all treatments, even in the treatment which did not use cover.

Keywords: Conduction system, Biomanta, Solanum lycopersicum.

1. Introduction

The tomato crop is of great importance in world food as it is among the main vegetables produced and marketed in the world. Brazil is among the ten largest producers in the world, with emphasis on the state of Sergipe when compared to other states with the largest territorial area, which occupies the tenth position of the states with the highest productivity, this is possible due to the climate favorable to vegetative development. of culture. However, it is necessary to implement techniques that provide greater optimization of resources and increase in productivity, ensuring the sustainability of production.

Several techniques are implemented in tomato cultivation, among them, the soil cover for the benefits it presents such as temperature regulation, moisture retention, growth inhibition and reduction of spontaneous weeds germination and the creation of microclimate, providing a better development. vegetative the plants.

There are several scientific works in the world which have evaluated the use of the most varied types of ground cover with different raw materials, highlighting the use of coconut fiber, straw, sawdust, forage, polyethylene and others. Among the scientific community, it is possible to observe several positive results with the use of ground covers in relation to exposed soil (Sediyama *et al.*, 2003). However, comparisons between the staking system and the interaction with the different types of coverage are rarely used.

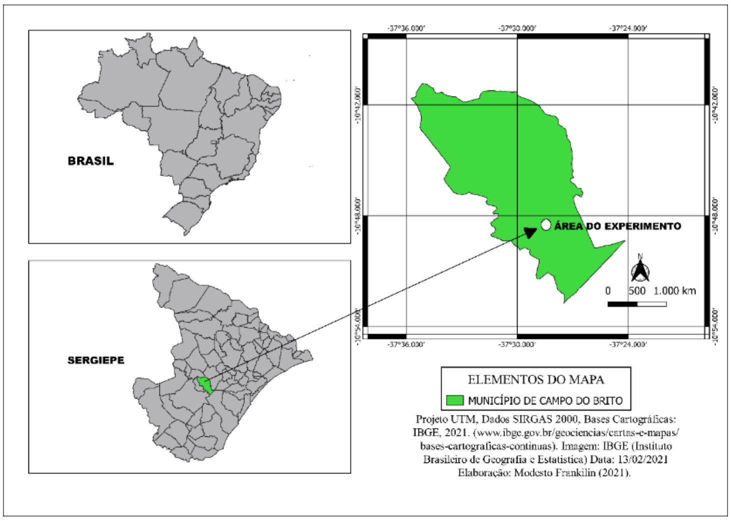
Considering the existence of few publications that relate the efficient use of soil mulches in tomato cropping systems. it becomes necessary to approach this topic, because it is an innovation in tomato culture and that can benefit the production system, with few works related to the staking system with the interaction of different types of coverage.

2. Method

2.1 Characterization of the study área

The work was carried out in the village of Garangau, in the municipality of Campo do Brito, Sergipe, in a sandy loam soil, in an agricultural area located 72.3 km from Aracaju, whose geographic coordinates are 10º 32' 58" south latitude and 37º 32' 04" west longitude, with an altitude of 272 meters above sea level.

Figure 1: Location of the experimental area, located in the village of Garangau, municipality of Campo do Brito, Sergipe.



Source: own authorship.

2.2 Climate and Relief

The municipality of Campo do Brito is located in the mesoregion of Sergipe, with a dry and sub-humid megathermal climate (EMDAGRO, 2019), an average annual temperature of 24.5 ºC, an average annual rainfall of 1,178.7 mm and a rainy season of March to August. The relief is characterized by a pediplaned and dissected surface, and the most common shapes are trays, hills and ridges, with drainage depth from very weak to weak. (EMDAGRO, 2019).

2.3 Experimental design and treatments

Two experiments were carried out in a contiguous area, using tomato (*Lycopersicum esculentum* L), under two cultivation conditions: 1. With tutoring (CT) and 2. Without tutoring (ST). In each experiment, four treatments were evaluated regarding the types of soil cover: 1. Biomat with grammage 600 (B600), 2. Biomat with grammage 800 (B800), 3. Soil raffia (RF) and 4. Soil without cover (SC).

In the tutored crop, the experimental plot consisted of two beds of 50 cm wide and 4.8 m long, spaced 0.70 m apart. In the cultivation without staking, the plot consisted of two beds of 1.30 m wide and 4.8 m long, spaced 0.70 m apart.

Each bed had a row of eight plants, with the six central plants of each row being considered useful, totaling 16 plants per repetition, with 12 useful plants. The transplant to the field was carried out on 10/03/2019. In the tutored system, the spacing was 1.20 m between rows and 0.60 m between plants, resulting in a density of 13,888 plants per hectare. In this cultivation system, thinning was performed, leaving two stems/plant. In the system without staking, the plants were conducted without thinning, with a spacing of 2.0 m between rows and 0.60 m between plants, resulting in 8,333 plants per hectare.

For both cultivation systems, the tomato cultivar Mariana was used, which can be cultivated with and without staking. Eight harvests were carried out and the total fruit production per plant and per hectare were evaluated.

In the tutored cultivation, the thinning was performed leaving two stems per plant while in the non-tutored cultivation, the thinning was not performed. In both crops, eight harvests were carried out, accounting for the total production of tomatoes, per plant and per hectare.

2.4 Soil fertilization in the experimental area

Fertilizers for planting and covering were defined according to the results of the soil analysis, using, per hectare, 300 kg of P^2O5 (70% at transplanting and 30% at 40 days after transplanting - DAT), 200 kg of K^2O (20% at transplanting, 20% at 25 DAT, 30% at 45 DAT and 30% at 70 DAT) and 100 kg of N (10% at planting together with organic fertilization, 30% at 25 DAT, 30% at 45 DAT and 30% at 70 DAT), using Gafsa hyperphosphate, potassium sulfate and castor bean pie as sources (recommendation adapted from Ribeiro, Guimarães and Alvarez V., 1999).

2.5 Irrigation system

The irrigation system located in the superficial drip method was used, using a drip tube installed under the cover (except for SC treatment) for each planting row, with emitters spaced at 0.3 m and a nominal flow rate of 2 L/hour. It was decided that irrigation management was carried out in accordance with the producer's current practice.

2.6 Monitoring of temperature, soil moisture

The effect of mulching on the soil for the parameters of soil moisture and temperature was evaluated. Due to material limitations, these evaluations were performed in only three repetitions per analyzed date. Measurements were carried out throughout the cultivation cycle, with a daily frequency, always at 2 pm.

The monitoring of soil moisture occurred through the matrix potential in the soil, in (millibar), was carried out by installing a battery of tensiometers. This battery consisted of two puncture tensiometers, installed at a soil depth of 0.15 m and 0.30 m. To measure the potential, a digital tensimeter was used, with a precision of 1 millibar.

To monitor soil temperature, in ºC, a digital thermometer was used, with a precision of 0.1 ºC, the variable being measured at depths of 0.05 and 0.12 m.

2.7 Statistical analysis.

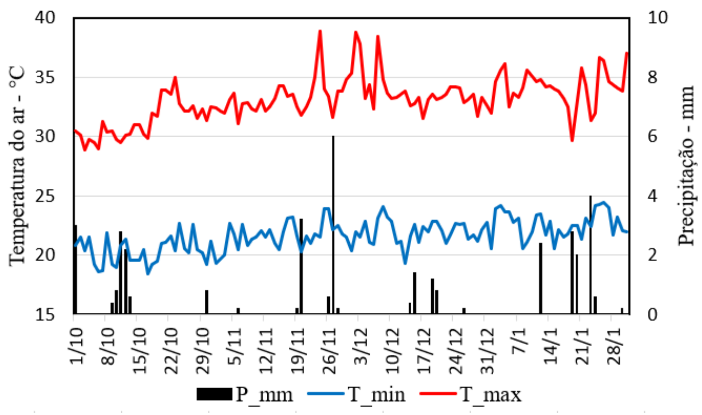
For both experiments, a randomized block design was used, with four treatments (ground cover) and three replications. For the production variables, the F Test was used, in the analysis of variance and the Tuckey Test, at the level of 5% of probability, to compare the averages of the treatments. And normality test (Shapiro-Wilk). And factor analysis To perform the statistical analysis, the program R. 3.6.1 (R CORE TEAM, 2020) was used.

3. RESULTS AND DISCUSSION

3.1 Climatic data during the period of execution of the experiments.

Based on climatological data during the summer climatological period, during the period of execution of the experiments (Fig.2), a maximum temperature variation of 38ºC was observed during the period of the experiment, referring to the end of November and the beginning of December, while the minimum temperature remained uniform. The rainfall was low, ranging from 0 mm to 6 mm.

Figure 2: Temperature and daily rainfall, during the period of execution of the experiments.



Source: INMET meteorological station (2020).

3.2 Influence of cover type on soil temperature in both tomato cropping systems.

In the cultivation system without staking (creeping) there were variations in soil temperature for each type of cover in the depth of 0.05 m (Fig.3) and 0.12 m (Fig. 4). A similar behavior was observed between coverages B600 and B800 until the 55th day after transplanting to the two depths. At a depth of 0.05 m there was a reduction in soil temperature, ranging from 2 ºC to 3.5 ºC. At a depth of 0.12 m, the same covers provided a reduction in soil temperature between 2 ºC and 3 ºC. Using the RF cover, a reduction in soil temperature was obtained from 1.90 ºC to 2 ºC, until the 55th day after planting.

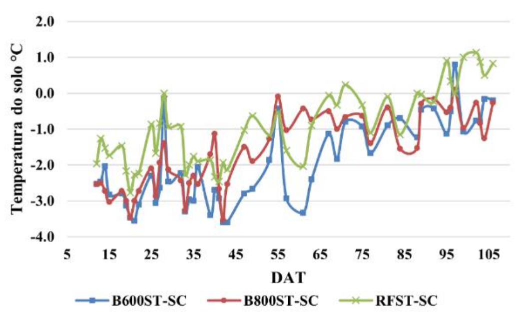
In the cultivation system with plant tutoring, there were temperature variations for the different coverages and depths of 0.05 m (Fig.5) and 0.12 m (Fig.6). Different behaviors are observed in the reduction of soil temperature, where B800 showed a reduction between 3 ºC to 4 ºC until the 55th day after transplanting, B600 showed a reduction of 2 ºC to 3.2 ºC, and the RF coverage showed -0.5 ºC at the beginning reaching -4ºC on the 55th day, however it fluctuated between -1 ºC to -2.2 ºC.

However, at a depth of 0.12 m, conducted with the staking system, it can be observed that the B800 cover showed a reduction between 2 ºC to 3.2 ºC, followed by B600 with a reduction of 1 ºC and 2.1 ºC. and the RF coverage showed a reduction of 1 ºC to 3 ºC with a change at the 55th day which a reduction of 3.5 ºC can be observed.

It is observed that for all treatments there was a decrease in temperature on the 55th day after transplanting, this may be related to a precipitation that possibly occurred in this period. However, after the 55th day, there was a gradual increase in soil temperature, which may be related to the high temperatures in the region where the experiment was implemented, since it is characterized as a summer season with high temperatures.

These results are in agreement with Resende *et al.* (2005), who observed that the use of mulch in the soil proved to be an advantageous practice for the summer cultivation of carrots, reducing the temperature by up to 3.5 ºC. Also according to Gasparim *et al*., (2005), soil cover is mainly observed in regions with predominance of high temperature, where its use results in soils with milder temperatures, including reducing large fluctuations throughout the day and in the profile. According to Gasparim *et al*., (2005) also observed a reduction in soil temperature of up to 9 ºC, when mulching was used on the soil surface, in which they observed temperatures above 40 °C in soil without cover and 31 ºC in soil with cover. In studies carried out by Cademartori *et al.* (2010), evaluating soil temperature and thermal amplitude, also found lower values in soils with mulch when compared to soil without cover, in ryegrass cultivation.

Figure 2: Soil temperature at a depth of 0.05 m, using the technique of steering system



without tutoring.

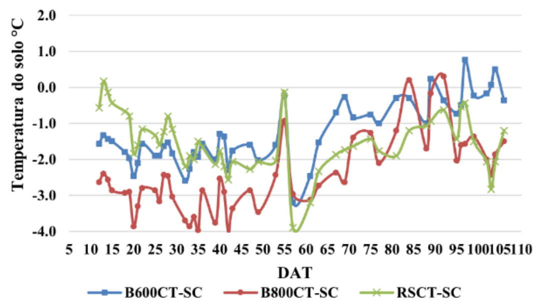
Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF).

Figure 4: Soil temperature at a depth of 0.12 m, using the technique of steering

system without staking.

Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF).

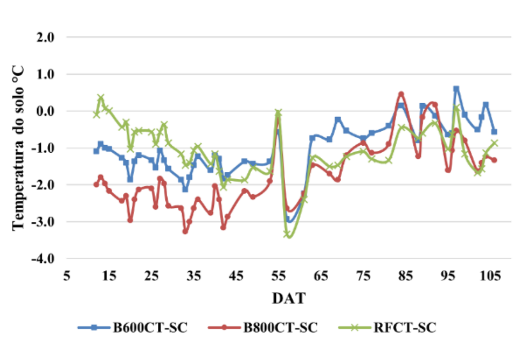
Figure 5: Soil temperature at a depth of 0.05 m, using the steering system technique with



staking.

Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF).

Figure 6: Soil temperature at a depth of 0.12 m, using the steering system technique



with staking.

Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF).

3.3 Soil temperature at different depths

Plant growth and development are related to several factors, such as soil temperature at different depths. There was significance for soil cover in both cropping systems and in both depths, in relation to soil temperature. In (Table 1), significant effects of soil cover on temperature control at depths of 0.05 m and 0.12 m were observed, referring to treatments of coverings Biomat with grammage 800 (B800), Biomat with grammage 600 (B600), Soil raffia (RF) and Soil without cover (SC). Based on the results, it was possible to observe that, at a depth of 0.05 m, the Biomat treatment with grammage 600 (B600), without staking corresponding to a temperature of 31.08 ºC, was statistically equal to the Biomat treatments with grammage 800 (B800), without staking corresponding to a temperature of 31.41 ºC, these were superior to the RF treatments without and with staking, to SC without and with staking and to B600 with staking. These results are in agreement with Vieira *et al.*, (2020) who reported a positive correlation of soil temperature with and without cover.

Table 1: Soil temperature averages under different coverages (B800, B600, RF and SC) at depths of 0.05m and 0.12m.

		0,05 m		
Treatments	**B800**	**B600**	**RF**	**SC**
With tutoring	31,32^{c}	32,50^{b}	32,24^{b}	33,79^{a}
no tutoring	31,41^{c}	31,08^{c}	32,09^{b}	33,08^{a}
CV %	4,79	7,20	5,02	5,78
	5,11	4,44	4,69	5,34
		0,12 m		
Treatments	**B800**	**B600**	**RF**	**SC**
With tutoring	30,85^{c}	31,64^{b}	31,66^{b}	32,67^{a}
no tutoring	30,84^{c}	30,53^{c}	31,60^{b}	32,35^{a}
CV %	4,27	5,49	4,13	4,94
	4,43	3,70	4,02	4,16

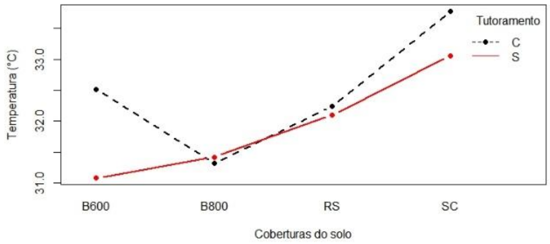
Tutoring: with tutoring; no tutoring; bioblanket with grammage 800 (B800), bioblanket with grammage 600 (B600), soil raffia (RF) and soil without cover (SC). Means followed by the same lowercase letters, on the line, do not differ statistically by Tukey's test at 5% probability.

There was significance for soil temperature control for the depth at 0.12m (Table 1), it was possible to observe that the B600 treatment without staking proved to be statistically more efficient, which corresponds to an average temperature of 30.53 ºC when compared to RF treatments without staking and to SC without staking. However, it can be observed that the B600 without staking was equal to the B800 without staking corresponding to an average temperature of 30.84 ºC. According to Gasparim *et al.*, (2005), the use of mulch on the soil contributes to reducing the temperature of the soil, and this happens due to the thermal properties of the materials used in the cover, which constitute a physical barrier, which avoid the direct incidence of solar radiation, reducing 1 reducing the heat in the different layers and the effect of this interference varies according to the depth (PEREIRA; ANGELOCCI AND SENTELHAS, 2002).

3.4 Comparison between soil cover and cropping system in the soil temperature parameter at depths of 0.05 m and 0.12 m.

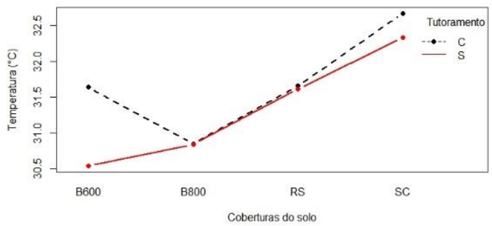
When analyzing the (Figures 7 and 8), it was observed the interaction of the coverings in function of the technique of conducting the cultivation (with and without staking) in the soil depths of 0.05 m and 0.12 m. In (Figures 7 and 8), a significant difference was observed (significance is observed for the interaction between the factors temperature and cover and staking cover), in this way it is possible that the results influenced during the vegetative development phase of the plants together with the tutoring technique.

Figure 7: Average soil temperature at a depth of 0.05m as a function of coverage and



cultivation systems.
Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF).

Figure 8: Average soil temperature at a depth of 0.12m as a function of coverage



and cultivation system.
Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF).

A greater rise in soil temperature is observed in the tutored cropping system (Fig.8), which may be due to the fact that there is less interception of sunlight by the leaves, consequently a greater incidence of light on the soil, promoting an increase in the temperature on its surface. Corroborating this, Lédo *et al.*, (1998) and Rughoo and Govinden, (1999), and for altering the distribution of solar radiation and ventilation around plants Andriolo (1999).

In the low-growing system (without staking), the vegetative growth provides a larger leaf area, thus creating a microclimate region causing a reduction in the temperature on the soil surface together with the tested cover. Corroborating this, Arora *et al.*, (2011) and Pramanik *et al*., (2015) point out that mulch changes soil temperature, affecting the thermal regime and protecting the soil surface from sunlight. Second, Abouziena and Radwan (2015), mulching reduces the fluctuation of soil moisture and soil temperature.

4. Tomato productivity

In Table 2, it is possible to observe the tomato yield under different mulches, in two cultivation systems (with staking and undergrowth). It can be observed that when the staking technique was used, there was a greater productivity in relation to the one without staking. It is noticed that the treatment, B600 was statistically better in the productive yield, when cultivated without the staking technique. However, they obtained lower values of productivity per hectare when cultivated without and with staking in the SC treatment.

Table 2: Tomato yield (Ton-¹.ha) under different soil cover and cropping systems.

Productivity per hectare (no tutoring)				
Treatments	**B800**	**B600**	**RF**	**SC**
no tutoring	59.69^{a}	59.88^{a}	51.98^{a}	36.51^{b}
CV %	9.71	9.04	8.91	11.11
Produtividade por hectare (with tutoring)				
Treatments	**B800**	**B600**	**RF**	**SC**
with tutoring	79.69^{b}	94.17^{a}	72.03^{b}	55.93^{c}
CV %	6.21	4.04	13.23	12.06

With: with tutoring; Without: no tutoring; Bioblanket with grammage 800 (B800), Bioblanket with grammage 600 (B600), Soil raffia (RF) and Soil without cover (SC). Means followed by the same lowercase letters in the column do not differ statistically from each other at the 5% probability level.

However, it can be observed that the B600 treatment with the use of staking showed a statistically higher value regarding productivity per hectare, when compared to B800 and RF, which were statistically less productive. The SC treatment had the lowest productivity among all treatments.

These results, which show greater productivity when using the staking technique, may be related to the effect of tomato management. Corroborating this, Zambolim *et al*., (1989) emphasize that they obtained greater production of large fruits when the vertical conduction method was used. The conduction of plants with two stems may also have contributed to result in higher production, considering that the thinning system was not performed in the creeping system. Corroborating this, Hesami *et al*., (2012) emphasize that the management of plants with two stems can result in greater commercial production, but it can imply in the production of fruits of smaller average size. A similar result was also obtained by Wamser *et al.*, (2007), who obtained greater production of larger diameter fruits in different vertical staking systems.

According to Wamser *et al*., (2007), the increase in fruit size in the conduction of plants with two stems may be related to the lower competition between plants for water and nutrients and to the lower number of drains, fruits, per plant when compared to the creeping system which was not thinning technique (CARVALHO AND TESSARIOLI NETO, 2005; CHARLO *et al*., 2009).

5. CONCLUSION

The use of Bioblanket with grammage 600 (B600), and the bioblanket with grammage 800 (B800) without staking respectively, provided a reduction in soil temperature between -3.0 ºC to -4.0 ºC. Tomato productivity per hectare was higher when using the staking system for all treatments, even in the treatment which did not use cover.

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