Universidade Federal Rural do Semi-Árido
Pró-Reitoria de Pesquisa e Pós-Graduação
https://periodicos.ufersa.edu.br/index.php/caatinga

ISSN 0100-316X (impresso)
ISSN 1983-2125 (online)
http://dx.doi.org/10.1590/1983-21252023v36n102rc

Ornamental cherry tomatoes in different protected environments and reflector materials in cultivation Bench

Tomateiro cereja ornamental em diferentes ambientes protegidos e materiais refletores em bancada de cultivo

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ABSTRACT - The study aimed to evaluate the growth of ornamental cherry tomato plants in different protected environments and reflective materials on the cultivation benches. As there were no repetitions of the protected environments, each environment was considered an experiment. In each environment, the experimental design used was completely randomized with five replications and three plants per plot. From the analysis of individual variances and evaluation of the mean squares of residues smaller than seven, the joint analysis of variance was performed (three protected environments x three reflective materials on the cultivation bench + 1 control without material). The protected environments evaluated were the agricultural greenhouse with a screen of 42-50% shading under the film, the agricultural screenhouse with a black screen of 30% shading, and the agricultural screenhouse with an aluminized screen of 35% shading. The reflective materials on the cultivation bench were Aluminet®, white Formica laminate, and red Formica laminate. The different protected environments influenced the growth of plants, and due to the lower incident light, the plants showed greater height in the agricultural greenhouse (42-50% shading). The reflective benches did not interfere with plant height but favored fruit production. The agricultural greenhouse (42-50% shading)) stands among the environments. For the reflective materials on the bench, aluminized fabric and red Formica laminate stood out, as they favored the growth of cherry tomato plants with desirable ornamental traits, such as greater fruit production.

Keywords: Microclimatic conditions. Radiation. Shading. Luminosity.

RESUMO - Objetivou-se com esse trabalho avaliar o crescimento de plantas ornamentais de tomateiro cereja em diferentes ambientes protegidos e materiais refletores sobre as bancadas de cultivo. Por não haver repetições dos ambientes protegidos, cada ambiente foi considerado um experimento. Em cada ambiente, o delineamento experimental utilizado foi o inteiramente casualizado com cinco repetições e três plantas por parcela. A partir das análises de variâncias individuais e avaliação dos quadrados médios dos resíduos menor que sete foi realizada a análise conjunta (três ambientes protegidos x três materiais refletores sobre a bancada de cultivo + 1 uma testemunha sem material). Os ambientes protegidos avaliados foram a estufa agrícola com tela de 42-50% de sombreamento sob o filme, o telado agrícola com tela preta de 30% de sombreamento e o telado agrícola com tela aluminizada de 35% de sombreamento. Os materiais refletores sobre a bancada de cultivo foram o Aluminet®, o laminado de fórmica branca e o laminado de fórmica vermelha. Os diferentes ambientes protegidos influenciaram no crescimento das plantas, sendo que em função da menor luminosidade incidente, as plantas apresentaram maior altura na estufa plástica. As bancadas refletoras não interferiram na altura de plantas, mas favoreceram a produção de frutos. Dentre os ambientes destaca-se a estufa plástica 42-50% de sombreamento. Para os materiais refletores na bancada, destacaram-se o material aluminizado e a fórmica vermelha, pois favoreceram o crescimento de plantas de tomateiro cereja com características ornamentais desejáveis, como maior produção de frutos.

Palavras-chave: Condições microclimáticas. Radiação. Sombreamento. Luminosidade.

Conflict of interest: The authors declare no conflict of interest related to the publication of this manuscript.

Received for publication in: May 05, 2021.
Accepted in: July 12, 2022.

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INTRODUCTION

Tomatoes are in high demand due to their different shapes, sizes, colors, and flavors, and cherry tomatoes (*Solanum lycopersicum* var. *cerasiforme*), being smaller and serving as a decorative object, are being widely used as an ornamental plant in pots. Due to their higher added value, ornamental plants are mostly grown in protected environments. Cherry tomato cultivars “Pêra Amarela”, “Pêra Vermelha”, and “Carolina” have a higher yield in a protected environment with a black screen with 50% shading compared to an agricultural greenhouse with plastic film and aluminized screen with 50% shading under the film (COSTA et al., 2015).

In the comparison between full sun and protected environment with Chromatinet Silver 35% shading screen, under different irrigation depths and intermittence, higher cherry tomato yields were observed at 75% of the evapotranspiration of the crop for the protected environment and 100% for full sun, intermittency did not influence yield, and in the open air, it was greater than in the protected environment (FRANCA; LEITÃO; CAMPECHE, 2017).

As can be seen, within protected environments, technologies that provide better cherry tomato yields have been evaluated, and in the literature, no studies were found with reflective material in cultivation benches for this species. The reflective material aims to increase the offer of radiation to the abaxial part of the leaves, and a positive effect was verified in improving the quality of parica (*Schizolobium amazonicum* Huber) seedlings with the use of aluminum foil in an agricultural greenhouse with a 42/50% shading under the film (MORTATE et al., 2019), as well as seedlings of jambolan (*Syzygium cumini* (L.) Skells) in an agricultural screenhouse with 30% shading (SALLES; LIMA; COSTA, 2017). The use of a mirror on benches for passion fruit seedlings (*Passiflora edulis* Sims. f. flavicarpa Deg) provided a higher growth rate and shoot dry matter compared to faux sequin fabric (SANTOS et al., 2017).

In ornamental pepper (*Capsicum frutescens* L.), the brown container under an agricultural greenhouse and 18-22% shading thermoreflective screen and the red container under an agricultural greenhouse and 42-50% shading thermoreflective screen positively influenced growth and yield when compared to the production in a black container, and the blue container showed a delay in flowering (COSTA et al., 2020a), however, colored reflective materials (blue and red) and silver reflective on the benches did not influence the growth and production of the pepper plant, which presented a greater amount of fruits in an agricultural greenhouse and a thermoreflective screen of 42-50% shading compared to an agricultural greenhouse and thermoreflective screen with 18-22% shading and agricultural screen with 18% shading (LIMA et al., 2018).

The cultivation of ornamental plants, practically in its entirety, is conducted in protected environments to promote greater protection and guarantee production quality since the traits that determine an ornamental plant involve reduced height, smaller leaves, and showy and colorful fruits (BARROSO et al., 2012). According to Moreira and Lopes (2018), to seek the ornamental potential of plants, the main purpose is landscaping, such as leaves, flowers, and fruits, showy and vibrant colors, in addition to varied morphological traits, which make them attractive to the consumer for the composition of indoor environments.

The cultivation of ornamental plants inside protected environments can be beneficial since they favor greater control of micrometeorological elements, such as temperature, humidity, and radiation, associated with the reflective material on benches, there is a better distribution of luminosity, being able to improve the quality of the light spectrum.

The study aimed to evaluate the growth of ornamental cherry tomato plants (*Solanum lycopersicum* var. *cerasiforme*) in different protected environments and reflective materials on the cultivation benches.

MATERIAL AND METHODS

The experiments were carried out in the experimental area of the State University of Mato Grosso do Sul (UEMS), at the Cassilândia University Unit, from September to November 2019, in Cassilândia, MS, Brazil (19°07'21” S, 51° 43'15” W, and altitude of 516 m). The climate of the region is classified as rainy tropical (Aw) with rainy summers and dry winters, according to the Köppen climate classification (PEEL; FINLAYSON; MCMAHON, 2007).

Three experiments were carried out (different protected environments), each one in a completely randomized design, with four treatments (three reflective materials on the cultivation benches + control – without reflective material), five replications, and three tomato plants per plot.

The treatments were composed of reflective materials on the cultivation bench, the Aluminet® (Figure 1A), white Formica laminate (Figure 1B), and red Formica laminate (Figure 1C); these were arranged on metal benches 1.40 m wide x 3.50 m long x 0.80 m high. The control was the metallic bench described above, without reflective material (Figure 1D).

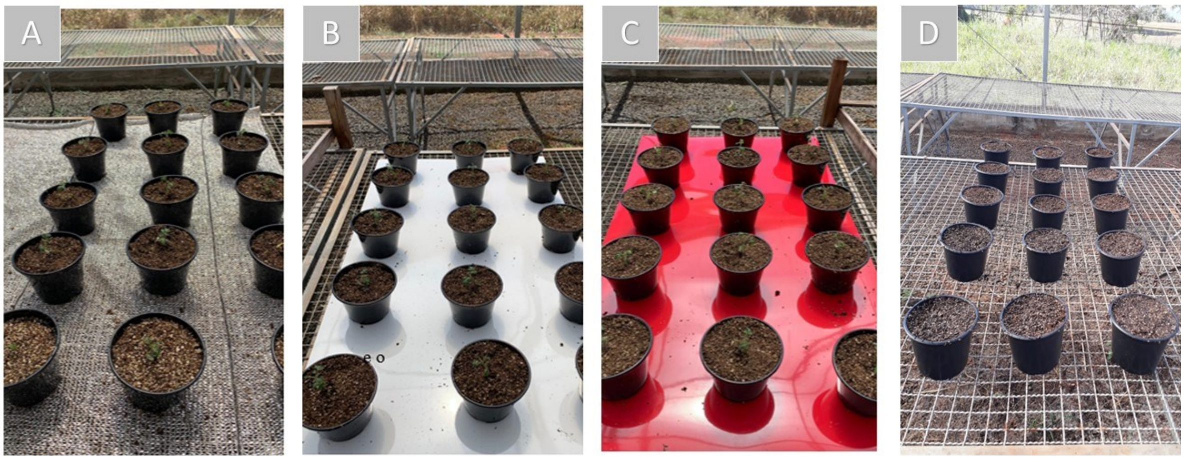

Figure 1. Cultivation benches with aluminet® (A), white Formica® laminate (B), red Formica® laminate (C), and (D) without reflective material - control.

The protected environments used were the agricultural greenhouse covered with a 150-micron low-density polyethylene film and a thermoreflective screen (LuxNet®) with 42/50% shading under the film (A1); the agricultural screenhouse with a black monofilament screen of 30% shading (A2), and an agricultural screenhouse with an aluminized thermoreflective screen of 35% shading (A3) (Figure 2).

Figure 2. Cultivation environments and cultivation benches, screen with aluminized thermoreflective screen 35% shading (A), agricultural screenhouse with 30% shading (B), and agricultural greenhouse 42/50% shading (C).

The growth of seedlings of the hybrid cherry tomato "Chipano" from the *Longa Vida Sais Isla®* line was carried out in an agricultural greenhouse covered with polyethylene film and a thermoreflective screen (LuxNet®) with 42-50% shading under the film (COSTA et al., 2015), and the sowing was carried out on 09/24/2019, in Styrofoam trays of 128 cells, with two seeds per cell, containing Carolina Soil® substrate, composed of 70% Sphagno Peat + 30% Vermiculite + Limestone.

Irrigation was performed using a suspended micro-sprinkler system with NETAFIM SPINNET emitters with an irrigation capacity of 70 liters per hour, programmed to irrigate every 12 hours. Supplementary soil fertilization was performed 30 days after transplanting into 1L pots, using 0.5 mg of NPK formulation (5-20-20) and 0.3 mg of urea. For pest control, an alternative solution was used (soap and water solution - 50 grams of coconut soap in 5 liters of hot water. After cooling, it was applied twice with a sprayer in the morning, only when there was an infestation of aphids (RODRIGUES; GONZAGA, 2001).

In each environment, the reflected photosynthetically active radiation (micromol/m^{-2}.s) was collected with a portable digital pyranometer, Apogee model MP-200, always measured at 10 am (local time – MS), without cloudiness, in each material with the sensor facing down at an average distance of 20 cm from the reflective material, and incident photosynthetically active radiation (micromol/m^2.s) inside and outside the protected environment with the sensor facing up, measuring the radiation at the center of the environment. Data on temperature (T °C), relative air humidity (RH%), and global solar radiation were also collected from meteorological stations model E4000 (Irriplus Scientific Equipment) installed inside and in the center of the environments.

At 35, 50, and 65 days after sowing (DAS), plant heights (PH), number of leaves (NL), and stem diameter (SD) were collected. The height of the seedlings was measured with a graduated ruler, measuring the distance from the soil surface to the apex of the apical meristem of the stem. The number of leaves was measured by counting, considering the leaves were fully expanded, and the stem diameter was measured with a digital caliper (mm). At 65 DAS, the number of fruits was also measured, and, due to its ornamental purpose in pots, it was decided to analyze only non-destructive variables.

The data were subjected to analysis of variance (F-test) for each of the three experiments individually, then the mean squares of the residuals were evaluated, and when the statistical assumptions were met, the joint analysis of the experiments was performed (BANZATTO; KRONKA, 2013). Means were compared using the Tukey test at a 5% probability level. The Sisvar statistical software was used (FERREIRA, 2010).

RESULTS AND DISCUSSION

The lowest average temperature was recorded in the aluminized screenhouse environment (Figure 3). The material constituting the aluminized screen, even having less shading and greater luminosity than the agricultural greenhouse (Figure 4), promoted greater reflectance of solar radiation, which may favor less heating inside, consequently lower temperature recording. The external conditions, as there is no irrigation system, presented the lowest mean relative humidity in the experiment period (Figure 3). There was no difference between the protected environments.

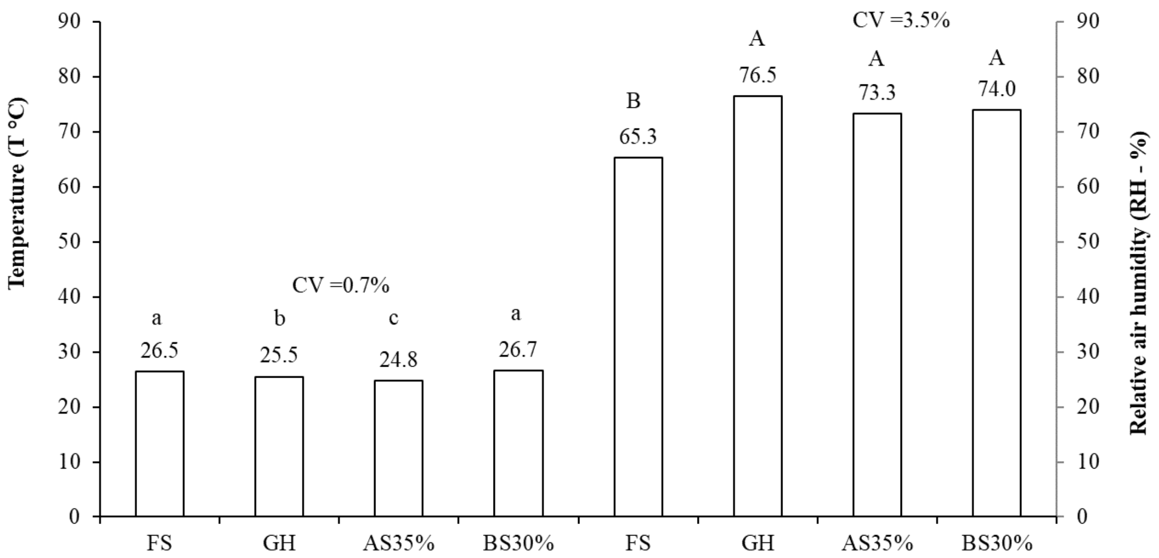

Figure 3. Temperature (T ºC) and relative air humidity (RH-%) in the different protected environments used to produce cherry tomato seedlings from October to November 2019. GH (Greenhouse 42/50% shading), AS35% (Aluminized screen 35% shading), BS30% (Black screen 30% shading) and FS (Full sun). CV = coefficient of variation. Means followed by the same lowercase letter for temperature and uppercase for relative air humidity do not differ from each other by the Tukey test at 5% probability.

Temperature, as well as radiation, are factors that interfere with photosynthetic mechanisms; in C3 plants, such as tomatoes, high temperatures can affect plant performance; however, in these plants, CO_2 assimilation reaches maximum values in the range of 20-30 °C (KERBAUY, 2013). Thus, the treatments provided mild temperatures that probably did not limit the photosynthetic performance of cherry tomatoes.

Global solar radiation (GSR) decreased as the internal shading increased in the environments, demonstrating variation between all environments (Figure 4). The GSR in the agricultural greenhouse, aluminized screen, and black screen were 25.4%, 34.2%, and 45.2% of the external GSR radiation (full sun) (Table 1), respectively, corresponding to what was observed by Paula et al. (2017), who verified the GSR in the winter period and obtained 29%, 39%, and 51% of the external, respectively. Room covering materials significantly reduced indoor GSR, in which 42-50% of screen plastic film under film was reduced by 74.6%, aluminized screen reduced by 65.8%, and 30% black screen reduced by 54 .8%.

Table 1. Percentage of global solar radiation (GSR) and photosynthetically active radiation (PAR) occurring in cultivation environments concerning external radiation.

Micrometeorological variables	Full sun	GH	AS35%	BS30%
Global radiation - GSR	100%	25.4%	34.2%	45.2%
Photosynthetic radiation - PAR	100%	30.5%	50.5%	60.7%

GH: Agricultural greenhouse with 42/50% shading screen under the polyethylene film; AS35%: Aluminized screen with 35% shading; BS30%: Black screen with 30% shading.

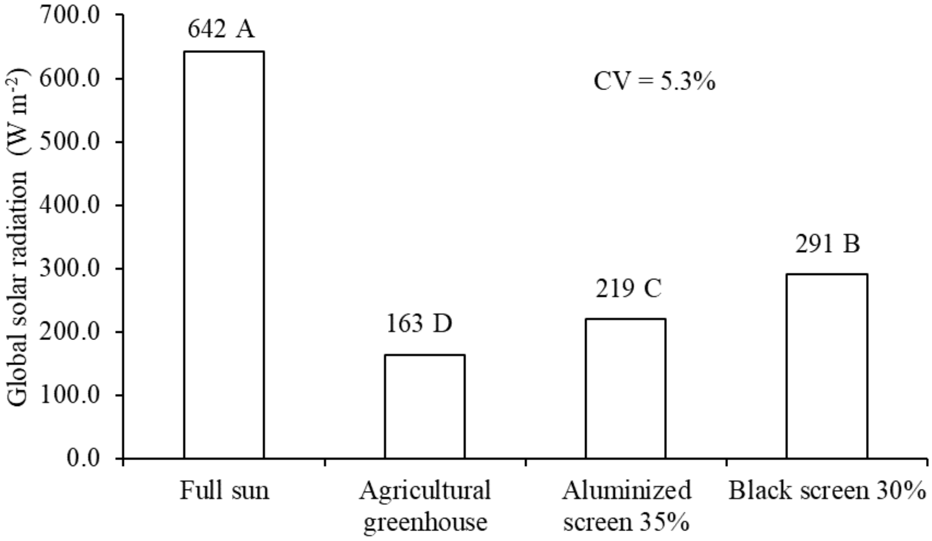

Figure 4. Global solar radiation (GSR, W m^{-2}) in protected environments and full sun during the growth of cherry tomato plants from October to November 2019. CV = coefficient of variation. Means followed by the same uppercase letter do not differ from each other by the Tukey test at 5% probability.

By monitoring the micrometeorological data collected in the different protected environments proposed in the experiment, it was observed that the incident photosynthetically active radiation (PAR) showed variation as a function of the increase in shading (Figure 5), similar to that observed for GSR (Figure 4), during the growth of seedlings and fruit production of cherry tomato. The measurement of internal PAR incidents in the agricultural greenhouse, aluminized screen, and black screen were 30.5%, 50.5%, and 60.7% of the external RPA radiation (full sun) (Table 1) at 10 am morning, respectively. It was observed with the results presented that the lowest photosynthetic radiation occurred in the agricultural greenhouse due to the greater protection structure compared to screened environments.

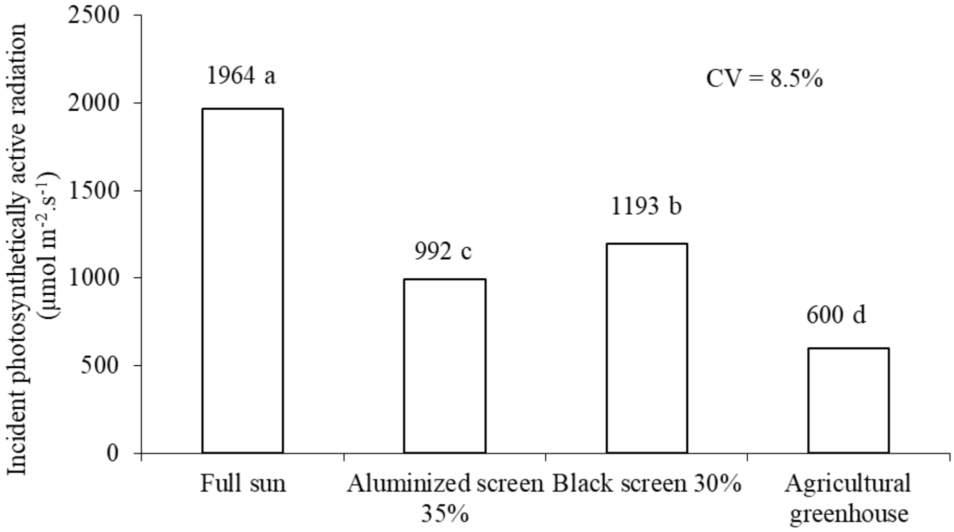

Figure 5. Incident photosynthetically active radiation (PAR, micromol/m^{-2} s^{-1}) in protected environments and full sun during the growth of cherry tomato plants from October to November 2019. CV = coefficient of variation. Means followed by the same lowercase letter do not differ from each other by the Tukey test at 5% probability.

The PAR reflected in the reflective materials was recorded. It can be seen that the white Formica reflected a greater amount of radiation than the other materials in the three cultivation environments studied (Figure 6). In the same way, in the environment with the black screen, the reflected PAR was higher, corresponding to a large amount of incident PAR concerning the other environments, as observed (Figure 5).

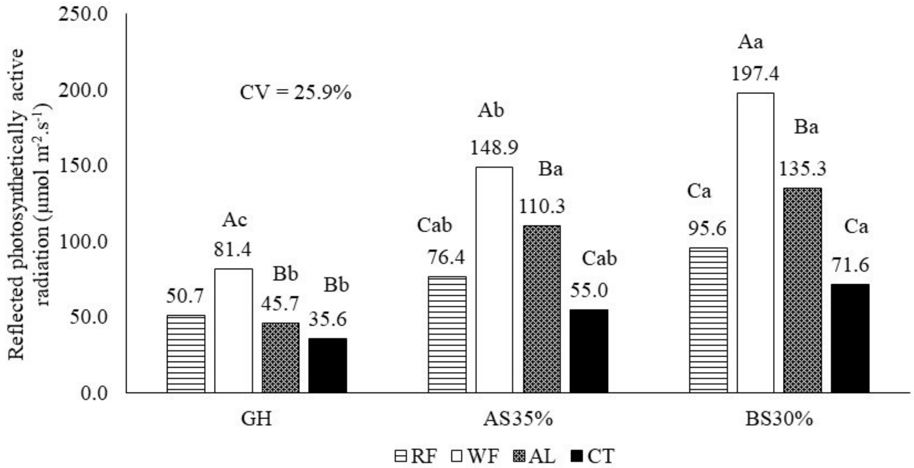

Figure 6. Reflected photosynthetically active radiation (PAR) in protected environments with red Formica (RF), white Formica (WF), reflective aluminized screen (AL), and control (CT) on the cultivation bench inside the protected environments. Means followed by the same lowercase letter for the protected environments within each reflective material and uppercase letters for the reflective materials within each environment, do not differ by the Tukey test at 5% probability. CV = coefficient of variation. GH (Greenhouse 42/50% shading), AS35% (Aluminized screen 35% shading), BS30% (Black screen 30% shading).

Except for the variable number of leaves at 65 DAS (NL3), the others showed a relationship between the highest and lowest mean square of the residue (RMSR) less than seven (7.0) (Table 2); thus, it was possible to carry out a joint analysis of the experiments and comparison of the types of protected environments (BANZATTO; KRONKA, 2013).

Table 2. Mean square of residues and ratio between the largest and smallest mean square of the residue (RMSR) for plant height at 35 (PH1), 50 (PH2), and 65 (PH3) DAS, stem diameter at 35 (DS1), 50 (DS2), and 65 (DS3) DAS, number of leaves at 35 (NL1), 50 (NL2), and 65 (NL3) DAS and number of fruits (Nfruit) of ornamental cherry tomato plants.

Mean Square of Residues										
Environments/Variables	SD1	NL1	PH1	DS2	NL2	PH2	SD3	NL3	PH3	Nfruit
Agricultural greenhouse	0.02	8.17	0.35	0.05	37.80	3.05	0.13	965.28	8.91	1.73
Aluminized screen	0.07	8.60	1.28	0.13	251.11	14.66	0.17	717.72	9.54	8.64
Black screen	0.04	4.71	1.37	0.21	43.06	7.20	0.13	95.79	4.79	3.37
RMSR	3.1	1.8	3.9	3.8	6.6	4.8	1.3	10.1	2.0	2.6

There was an interaction between shading levels in cultivation environments and the production system with reflective material on the cultivation bench. These interactions occurred in most of the variables studied, except for plant height at 50 DAS (PH2) (Table 3). These results indicate reciprocal influences between the factors studied to provide and improve the ambiance for a cherry tomato.

Cultivations bench with reflective material influenced plant growth in height at 35 and 65 DAS in the greenhouse with 42-50% shading under the film and in the aluminized screen with 35% shading. The cultivation bench with aluminized screen provided the largest plants at 35 DAS and 65 DAS; this system did not differ from the others in the agricultural greenhouse and red Formica in the aluminized screen environment (35% shading). The reflective materials did not differ in the black screen at 35 and 65 DAT. Plants with greater height were verified in a system with reflective material in the cultivation of Parica, and seedlings produced in the environment with plastic cover and 42/50% shading screen obtained greater heights in the first 30 days after transplanting (MORTATE et al., 2019).

Table 3. Analysis of variance of plant height at 35 (PH1), 50 (PH2), and 65 (PH3) DAS, stem diameter at 35 (SD1), 50 (SD2), and 65 (SD3) DAS, number of leaves at 35 (NL1) and 50 (NL2) DAS and number of fruits (Nfruit) of ornamental cherry tomato plants.

	SD1	NL1	PH1	SD2	NL2
Environment (E)	**	**	**	ns	**
Reflective material (RM)	**	ns	**	**	**
E x RM	**	**	**	**	**
CV	4.98	7.43	6.31	6.11	11.26
	PH2	SD3	PH3	Nfruit	
Environment (E)	**	*	**	**	
Reflective material (RM)	*	**	**	**	
E x RM	ns	**	**	*	
CV	6.81	5.98	5.17	18.7	

ns = not significant, * significant at 1%; ** significant at 5%. CV = coefficient of variation.

At 35 DAS, the seedlings in the greenhouse were larger than those in the other protected environments for all reflective materials. However, at 65 DAS, the largest plants were verified in the 35% aluminized screen environment for the control and aluminized screen production system and did not differ from the greenhouse with the Formica (Figure 7). Equivalent to this work, in the research by Costa et al. (2015), the same result was verified for the seedlings grown in the protected environment of the agricultural greenhouse (diffuser film) presented higher quality than those grown in the greenhouse, the possible explanation may be the result of the greater accumulation of radiant energy and the better efficiency of the use of this energy in the photosynthetic process.

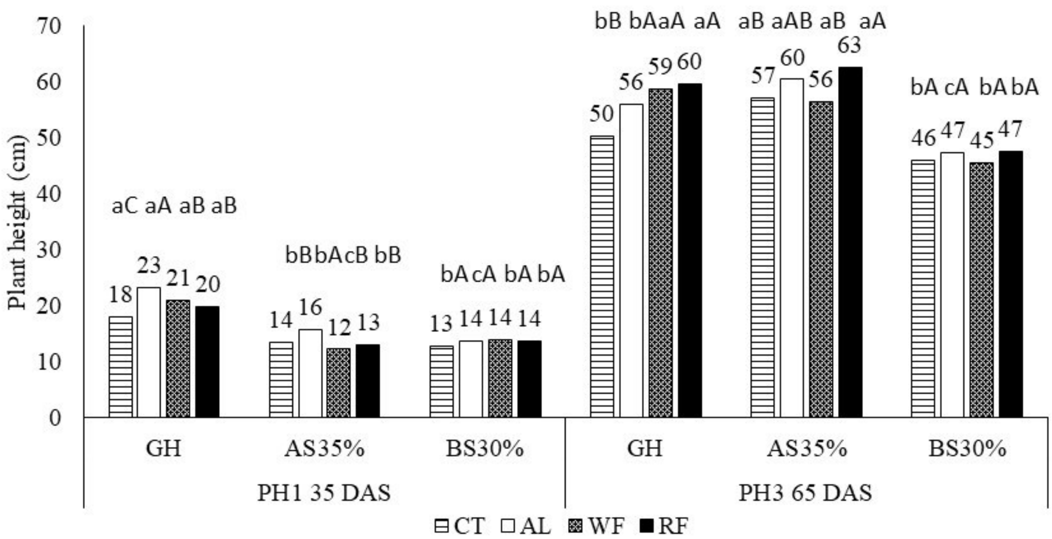

Figure 7. Plant height at 35 (PH1) and 65 (PH3) DAS of ornamental cherry tomato plants in protected environments (Agricultural greenhouse 42/50% shading – GH; Aluminized screenhouse – AS35%; Black screenhouse BS30%) with reflective material on the cultivation bench (Aluminized screen – AL; white Formica laminate – WF; red Formica laminate – RF; control, without reflective material on the bench – CT). Means followed by the same lowercase letter for the environments within each reflective material and uppercase letters for the reflective materials within each environment, do not differ by the Tukey test at 5% probability.

As Holcman (2010) had already explained in his study on microclimate and cherry tomato production, where he applied plastic covers (diffuser and anti-UV), noting that the environment with diffuser plastic generated higher accumulation of solar radiation and diffuse radiation, this factor is of great importance for the development and growth of the plant, since all the energy used in the photosynthesis process comes from this source.

In the study by Salles, Lima and Costa (2017), in the environments of 30 and 50% shading, larger seedlings of

Jambolan were verified because the solar radiation has its intensity reduced by the shading caused by the mesh of the protecting screen. The use of reflective benches promoted a better distribution of solar energy between the seedlings, thus favoring their better development.

The same results can be seen in Cabral et al. (2020); in their initial assessments of plant height (33 and 49 DAS), the highest plant heights occurred on the bench with aluminum foil or without reflective material, compared to the aluminized screen. Compared to the results observed in the present study, they were similar for the environments and cultivation benches in the variable plant height.

At 50 DAS, the largest plants were observed in the greenhouse, and there was no difference between production systems with reflective materials (Figure 8). The lower GSR and PAR in this environment (Figures 4 and 5) may have caused a possible tendency to etiolation, causing the plants to elongate their stems more; however, the higher radiation observed in the greenhouses affects plant growth, delaying the elongation of the hypocotyl, inhibiting stem growth.

As correlated by Taiz et al. (2017), photomorphogenesis is the process that mediates plant growth, and under conditions of restriction of solar radiation, the plant can present greater elongation of the hypocotyl in search of luminosity, which can lead to higher shoot growth, as observed in this study due to the greater height of plants in the agricultural greenhouse, and the tomato plant with ornamental potential the greater increase in size, is not one of the characteristics aesthetically aimed for this purpose.

Therefore, it appears that light acts as the main inducer of changes, driving signals to plants; these are intercepted by photoreceptors, allowing morphological responses of it; among them is phytochrome, a protein pigment that absorbs red, far-red, and blue light, which is linked to several conditions of plant development, such as photomorphogenesis. When light conditions are low, the degree of phytochrome in the form of far-red absorption is low (Pfr), thus inhibiting the sensitivity of the hypocotyl to gibberellin, causing endogenous gibberellins to enable greater cellular elongation of the hypocotyl, consequently leading to greater plant development (TAIZ et al., 2017).

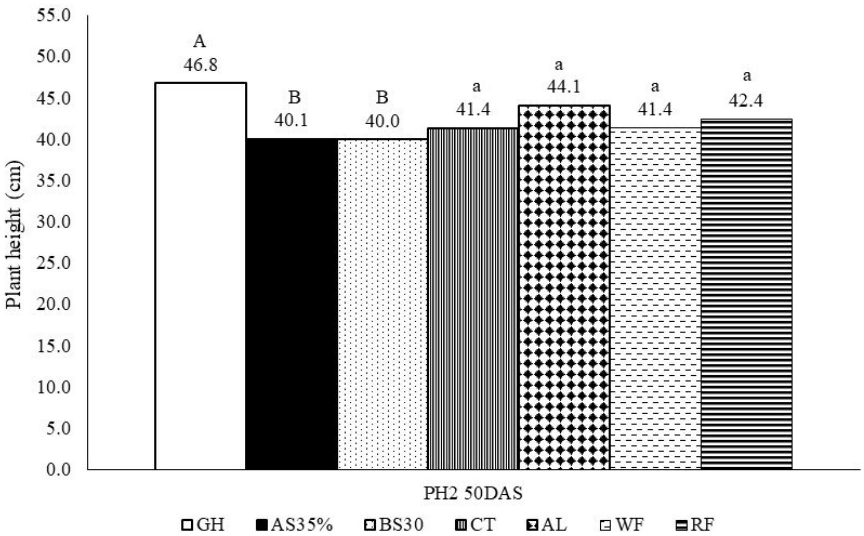

Figure 8. Plant height at 50 DAS (PH2) of ornamental cherry tomato plants in protected environments (Agricultural greenhouse 42/50% shading – GH; Aluminized screenhouse – AS35%; Black screenhouse BS30%) with reflective material on the cultivation bench (Aluminized screen – AL; white Formica laminate – WF; red Formica laminate – RF; control, without reflective material on the bench – CT). Means followed by the same lowercase letter for the reflective material and uppercase letters for the protected environments do not differ by the Tukey test at 5% probability.

For the stem diameter of cherry tomato plants, it was possible to observe that there was an interaction between environment x reflective materials (E x RM) at 35, 50, and 65 DAS; that is, for all evaluations of SD, it is observed that the reflective materials showed no differences in growth compared to the bench without reflective material. However, it can be observed that the largest diameters are found in the Agricultural Greenhouse 42-50% shading, on benches with aluminized screen and red Formica (Figure 9). The same result was found by Costa et al. (2020b), where reflected photosynthetically active radiation (PAR) was higher in cultivation benches coated with aluminized reflective material.

The use of red Formica material would be interesting as a cultivation bench due to the wavelength of the red light, which is directly related to the photosynthetic process since chlorophylls absorb light mainly in the red and blue range of the visible spectrum (TAIZ et al., 2017).

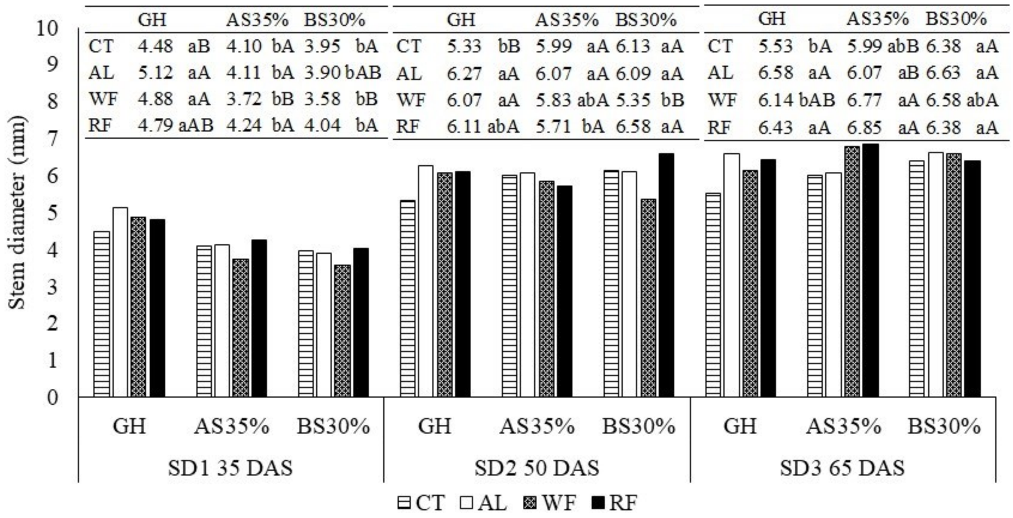

Figure 9. Stem diameter at 35 (SD1), 50 (SD2), and 65 (SD3) DAS of ornamental cherry tomato plants in protected environments (Agricultural greenhouse 42/50% shading – GH; Aluminized screenhouse – AS35%; Black screenhouse BS30%) with reflective material on the cultivation bench (Aluminized screen – AL; white Formica laminate – WF; red Formica laminate – RF; control, without reflective material on the bench – CT). Equal uppercase letters in the columns and lowercase letters in the lines for each variable do not differ by the Tukey test, at 5% significance.

Concerning the number of leaves, only in the black screenhouse with 30% shading, the use of the bench with reflective material positively influenced the higher number of leaves, as plants with more leaves were found in the red Formica than in the white Formica (Figure 10). As for the cultivation environments, in the two periods of analysis, at 35 and 50 DAS, it was observed that the cherry tomato plants had a higher number of leaves when cultivated in the agricultural greenhouse.

Thus, the cultivation environment caused morphological changes in the plant to increase its adaptation to the environmental conditions and ensure the perpetuation of the species. As verified by the data collected, in the agricultural greenhouse, there were conditions of lower irradiance and lower temperature; in this condition of a shaded environment, according to Taiz et al. (2017), to ensure greater capture of luminosity, plants tend to increase the leaf area, as this research shows that the plants developed a greater number of leaves.

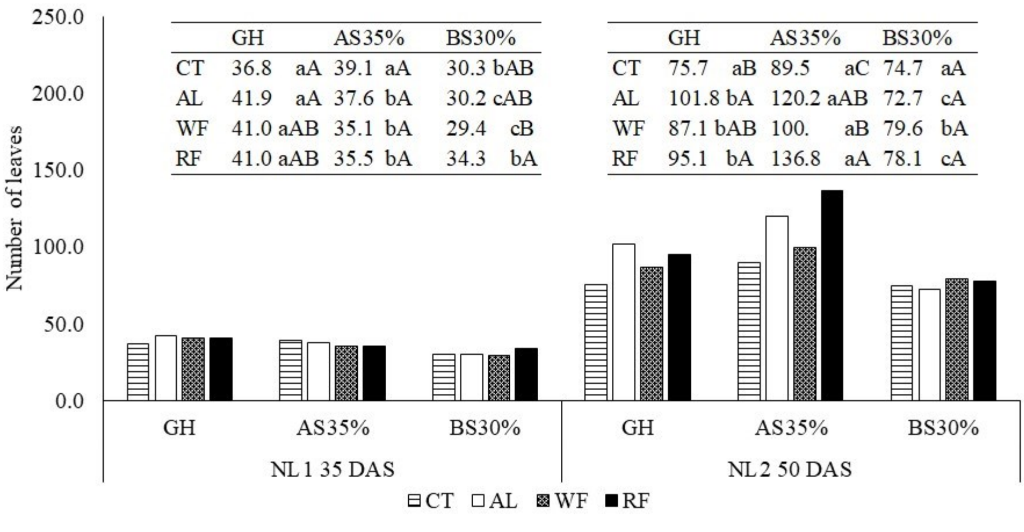

Figure 10. Number of leaves at 35 (NL1) and 50 (NL2) DAS of ornamental cherry tomato plants in protected environments (Agricultural greenhouse 42/50% shading – GH; Aluminized screenhouse – AS35%; Black screenhouse BS30%) with reflective material on the cultivation bench (Aluminized screen – AL; white Formica laminate – WF; red Formica laminate – RF; control, without reflective material on the bench – CT). Equal uppercase letters in the columns and lowercase letters in the lines for each variable do not differ by the Tukey test, at 5% significance.

As for the evaluation of the number of fruits, it is observed that the reflective bench positively influences the greater production of fruits, and in the agricultural greenhouse, the benches that provided the higher production of fruits were those of white and red Formica. In the aluminized screenhouse, red Formica provided the highest number of fruits but did not differ from the aluminized screen. In the black screenhouse, the white Formica provided the highest number of fruits that did not differ from the red Formica (Figure 11). In general, it is possible to analyze that the largest number of fruits were produced in the plants from the bench with red Formica.

Thus, the interaction that obtained the best responses in the number of fruits was the greenhouse with 42-50% shading on a bench with red Formica and white Formica; for the aluminized screenhouse with 35% shading, the white Formica presented the lowest performance; in the black screenhouse with 30% shading, white Formica stood out with better performance (Figure 11).

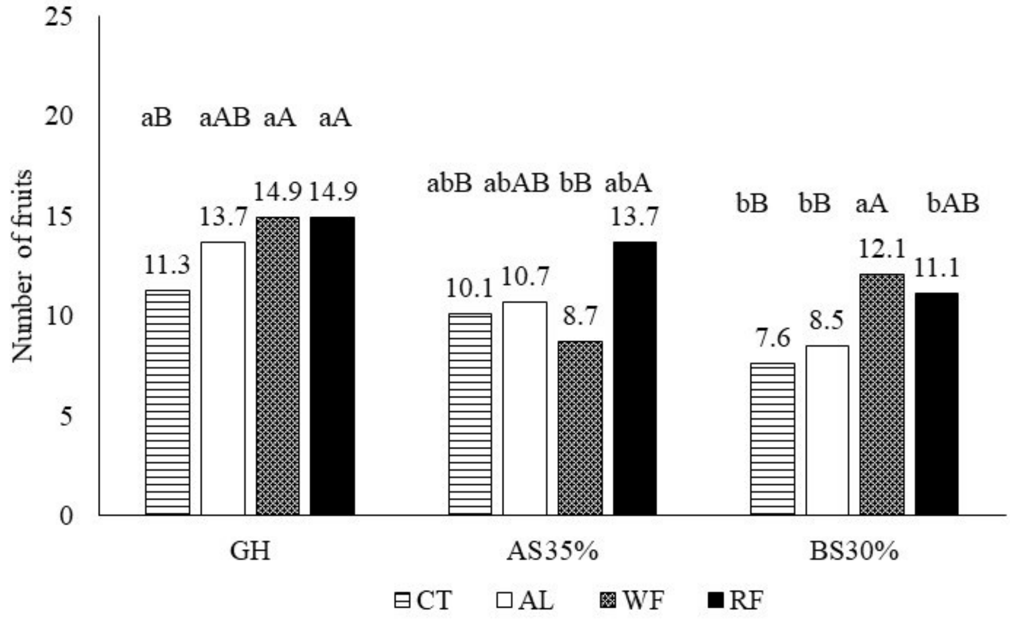

Figure 11. Number of fruits of ornamental cherry tomato plants in protected environments (Agricultural greenhouse 42/50% shading – GH; Aluminized screenhouse – AS35%; Black screenhouse BS30%) with reflective material on the cultivation bench (Aluminized screen – AL; white Formica laminate – WF; red Formica laminate – RF; control, without reflective material on the bench – CT). Equal uppercase letters in the columns and lowercase letters in the lines for each variable do not differ by the Tukey test, at 5% significance.

It is also noteworthy that there was low fruit production in the aluminized screen with white Formica, which is related to a large amount of reflected solar radiation and the high incidence of luminosity, which can promote elongation of the vegetative phase. In addition, the greater number of fruits from red Formica is related to the range of the light spectrum used by plants in the photosynthetic process. The energy absorbed by light is used to transfer electrons and essential compounds; chlorophylls absorb light more efficiently from the light spectrum in the blue (430 nm) and red (about 660 nm) region; red light stimulates growth, production of chlorophylls, and flowering (TAIZ et al., 2017). Thus, the higher incidence of the wavelength in the red, justified by the reflectance of the red Formica bench, favored a greater number of fruits.

The number of leaves at 65 DAS presents a ratio between the highest and lowest mean square of the residue greater than seven. The reflective materials in the protected environments were evaluated individually without performing a joint analysis. In the greenhouse, the plants on the aluminized screen on the cultivation bench had the highest number of leaves than those of the control and in the aluminized screenhouse with 35% shading greater than in the white Formica. In the black screenhouse, plants on the Formica had the highest number of leaves than the other treatments (Table 4).

Table 4. Number of leaves at 65 DAS (NL3)) of cherry tomato ornamental plants in protected environments (Agricultural greenhouse 42/50% shading – GH; Aluminized screenhouse – AS35%; Black screenhouse BS30%) with reflective material on the cultivation bench (Aluminized screen – AL; white Formica laminate – WF; red Formica laminate – RF; control, without reflective material on the bench – CT).

	Number of leaves at 65 DAS		
	GH	AS30%	BS35%
Red Formica	207.7 ab	170.1 a	167.5 ab
White Formica	211.3 ab	167.1 a	135.7 b
Reflective aluminum screen	219.6 a	145.3 b	192.1 a
Control	158.9 b	147.9 b	150.4 ab
CV (%)	15.6	6.2	16.6

Equal lowercase letters in the column for each variable do not differ by the Tukey test at 5% probability. CV= coefficient of variation. GH (Greenhouse 42/50% with shading), AS35% (Aluminized screenhouse with 35% shading), BS30% (Black screen with 30% shading).

Considering the results observed in this experiment, it can be said that using a colored cultivation bench brings promising results, generating high-quality ornamental plants with aesthetic better morphological traits, such as vigor, color, shape, and size of leaves and fruits. Possible studies that evaluate the effects of the temperature difference between day and night should be considered, which may improve the practicality and onerousness of this type of technology. Also, the cost of the reflective material may be replaced, using paints that allow the same reflective effect, and can be reproduced on a larger scale.

Concerning the cultivation environment, despite the agricultural greenhouse having formed plants with greater height, the height of the plants was not significantly different from the other environments, and the other characteristics, such as the greater number of leaves and fruits, are aesthetically valued characteristics for plants for ornamental purposes.

CONCLUSIONS

The use of reflective materials in shaded environments positively influenced the cultivation of ornamental cherry tomatoes. The red and white Formica in the agricultural greenhouse and black screenhouse, and the red Formica in the aluminized screenhouse, improved the number of fruits and demonstrated the efficiency of reflective materials, being possible their application on larger scales. The cultivation of cherry tomatoes in an agricultural greenhouse adds higher aesthetic quality to the production of ornamental plants.

ACKNOWLEDGEMENTS

To Fundação de Apoio ao Desenvolvimento do Ensino, Ciência e Tecnologia do Estado de Mato Grosso do Sul – FUNDECT (FUNDECT/CNPq/PRONEM – MS, Process 59/300.116/2015 – Nº FUNDECT 080/2015) for the finacial support. To the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the productivity grant. To Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the scholarship of the master degree student.

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