

Performance of lisianthus varieties in a shaded environment

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Abstract

Lysianthus cultivation is a recent activity when compared to the main cut flowers, and little is known about the techniques and the use of shading screens that can increase productivity in floriculture, resulting in favorable morphophysiological responses to the crop. The objective of this study was to verify whether shading screens impact the growth performance of lisianthus varieties. The experiment was carried out in a greenhouse in São Benedito farm, located in São Benedito, Ceará. The varieties studied were Lisianthus ABC 2-3 Blue, Lisianthus Allemade White and Lisianthus ABC 2-3 Rose, and three environments, one with aluminized screen (AS), one with red screen (RS) and the third environment without screen shading (WS). The experimental design was completely randomized in a 3 x 3 factorial scheme, with three environments and three varieties with three replications. The following were analyzed in cm: button diameter (BD); rod height (RH); actual size (AS); commercial size (CS); rod thickness (RT); and by counting, the number of buttons per stem (BS). The blue variety was better adapted to the conditions imposed by the AS environment, the rose variety presented the best results in the WS environment and the white variety, under the conditions of the experiment, would be unsuitable for the crop cultivation. The RS environment does not offer conditions conducive to satisfactory growth in rod size. Lysianthus cultivation is influenced by the use of shading screens.

Keywords: Floriculture. Ambience. Rod size

Introduction

Lisianthus (*Eustoma grandiflorum*) is an ornamental plant in the Gentianaceae family and is native to the southern United States (BACKES *et al.*, 2005). The cultivation of lisianthus had its expansion from the 80's, having noticed economic recognition from the 90's and today it is considered one of the main cut flowers in the world and in Brazil (SALVADOR, 2000).

The great popularity of lisianthus in the national market is attributed to its varied morphology, being able to present simple or folded flowers, with varied and bicolor tones, besides presenting long durability and easy handling (LEITE, 2006).

The crop has a cycle divided into two stages, in the first stage, which lasts an average of three

months, is when the seeds germinate. In this, the plant develops in the form of a rosette, until four pairs of fully formed leaves are reached. The second stage, after the first three months, is characterized by the elongation of the stem, the formation of new leaves and the beginning of flowering. With cycles that last from three to six months and characterize varieties with early, medium and late cycles (BACKES, 2004).

Despite the great potential of production and market, little is known about the cultivation of lisianthus in protected cultivation-colored screens, or photoselective or shading with varied color spectra, through which it is possible to combine physical protection and filtration of solar radiation and, consequently, promote physiological responses desired by light (SHAHAK *et al.*, 2004).

The screens promote an increase in the proportion of diffused light and, therefore, influence the absorption of different wavelengths (STAMPS, 2009). Plants make use of beacons that provide certain growth patterns, they respond to the quality of light, that is, to the wavelengths and the amount of light as irradiance (ALMEIDA; MUNDSTOCK, 2001).

Based on the above, the objective of this study was to verify whether shading screens impact the growth performance of lisianthus varieties.

Material and methods

The experiment was carried out in the municipality of São Benedito, Chapada da Ibiapaba, State of Ceará, altitude of 902 m, Köppen AW climatic classification, in a greenhouse for commercial production of cut lisianthus, with approximately 3.5 ha, louver height of 9 m and ceiling height of 6 m.

The experimental environments, 424 m² each, were classified according to the presence or absence of the shading screen. The control environment, without mesh (WM), had a plastic cover of LDPE - Low Density Polyethylene, 150 microns, with anti-ultraviolet and anti-static treatment. The environment using the red mesh (RM) and aluminized (AM) mesh as subcovering had 50% shading. The shading meshes covered the entire dimension of the experimental area, fixed at the height of the right foot, also extending about 1.5 m from the top of the sides. The purpose was that all sunlight reaching the plants was intercepted by the meshes.

Three varieties with folded petals were used: Lisianthus ABC 2-3 Blue - Balboa Series, Lisianthus ABC 2-3 Rose - Balboa Series, with seeds from Pan American Seeds and Lisianthus Allemade White, from Miyoshi Seeds. The seedlings, which were able to be planted after three months of sowing when they had three

leaves, came from the State of São Paulo, municipality of Holambra.

All cultural treatments, soil and irrigation management and other care in conducting cultivation were carried out in accordance with the recommendations for commercial crops, maintaining the care that all practices occurred simultaneously in all experimental areas.

To characterize the ambience of the experimental areas, a data logger model HOBO U23-001 was used to monitor the temperature and relative humidity of the air in each experimental environment (WM, RM and AM) and outside the greenhouse, in the external environment (EXT). These were fixed to a metallic structure at a height of approximately 80 cm from the ground. The data were collected automatically and stored every fifteen minutes.

Irradiance, which characterizes the intensity of solar energy, was represented by kriging maps. Sixty equidistant points in each environment were monitored with the aid of a lux meter. Lux units were converted to W m⁻². The spatial dependence analysis was validated by a semivariogram function model, obtained with the aid of the GS+ Geostatistical Program, version 5.1., that used the values in W m⁻² associated with their respective Cartesian coordinates. After the spatial dependence analyzes, the data were interpolated by the kriging method and the maps were prepared with the aid of the Surfer software, version 11.

As for the collection and analysis of the cut lisianthus variables, twenty samples of each variety in each treatment, considering the repetitions, which totaled 540 stems evaluated, occurred randomly from the moment of the aptitude for harvest, that is, after having expressed the maximum of their productivity; presenting at least one flower at the top at any opening point, being firm and erect, free from disease or physical damage.

With the aid of a measuring tape and a digital caliper, the following analyzes were carried out, in cm: diameter of the button (DB); stem height (H) - measured from the base to the last flower; actual size (AS) - measured from the base of the stem to the highest mature flower bud; commercial size (CS) - the harvested stem was standardized according to the commercial size, 50 cm, 60 cm and 70 cm, and, stem thickness (ST) - measured below the branches with flowers; and number of buds per stem (NB) - counting only mature flowers, and floral buds suitable for ripening.

The experimental design used was completely randomized in a 3 x 3 factorial scheme, the treatments were three environments (WM, RM and AM) and three varieties (blue, white and rose), with three replications.

With the cultivation data and using the Assisat 7.7 Statistical Program, each variable was subjected to the analysis of variance (Anova). The data referring to environments and varieties

(qualitative data) when significant by the F test, were submitted to the averages test (Tukey's test) at the level of 1% and 5% probability.

Results and discussion

In relation to the experimental environment, it was observed that the maximum air temperature was lower in the protected environment when compared to the value found in the external environment. The minimum temperature was higher in the different protected environments. In addition, the average temperature was slightly lower in environments with AM and VM, and practically the same in the EXT and WM environments (TABLE 1).

The relative and minimum air humidity, in the EXT environment, indicated a lower percentage when compared to the values presented in the protected environments. The maximum values were similar in the four environments evaluated (TABLE 1).

Table 1 – Values of temperature and relative humidity of the air, maximum, minimum and average in external environments (EXT) and environments using the aluminum mesh (AM), red mesh (RM) and environment without mesh (WM) as subcoverment, as well as as the coefficient of variation (CV) and standard deviation (σ), during the experimental period, Federal University of Ceará, São Benedito - CE, 2014

	Air temperature (°C)				Relative humidity of air (%)			
	EXT	AM	RM	WM	EXT	AM	RM	WM
Max	38.6	32.6	32.4	34.3	100	100	100	100
Min	17.8	18.5	18.2	18.2	27	44	45	42
Aver	24.1	23.2	23.2	24.6	73	83	83	75
CV (%)	22.52	7.04	15.15	17.94	29.12	21.96	17.17	17.74
σ	5.32	2.02	3.42	4.18	21.59	15.33	14.59	15.05

Source: Elaborated by the authors (2021).

The values related to temperature and humidity in the protected environment can be attributed to the size of the greenhouse, the height of the ceiling height, the side openings and the presence of lanterns.

López *et al.* (2018) studied varieties of *Physalis ixocarpa* under greenhouse and field conditions,

and unlike the present study, they observed that the average temperature was slightly higher in the protected environment and the relative humidity was slightly higher in the open environment.

Evaluating the efficiency of the use of shade meshes in greenhouses for tomato production, Ferrari and Leal (2015) found that the use of

the aluminum mesh, when compared to the environment only with the LDPE coverage, significantly reduced the maximum, minimum and average temperatures, as well as how it obtained the best adaptation to the climatic needs of the tomato.

Due to the transmittance observed in environments with plastic covers and shading meshes, the presence of more energy in the WM environment and the lower energy intensity in the RM and AM environment is justified, the WM environment had the highest average, 0.259 W m^{-2} , while the RM environment averaged 0.141 W m^{-2} and the AM 0.170 W m^{-2} for irradiance (TABLE 2).

Table 2 – Minimum, maximum and average irradiance values for the environment using the aluminized mesh (AM), red mesh (RM) and environment without mesh (WM), as well as the coefficient of variation (CV) and standard deviation (σ), during the trial period, Federal University of Ceará, São Benedito - CE, 2014

	Irradiance (W m^{-2})		
	AM	RM	WM
Max	0.235	0.201	0.365
Min	0.112	0.100	0.167
Aver	0.170	0.141	0.259
CV (%)	14.13	15.59	20.03
Σ	0.02	0.02	0.05

Source: Elaborated by the authors (2021).

According to Ivanov *et al.* (2008), plants grown in environments with excessive light radiation produce excess energy, causing damage to the photosynthetic apparatus, due to the formation of destructive oxidizing molecules (such as singlet oxygen radicals), resulting from photoinhibition. When the level of production of these molecules is influenced by stress, the plants immediately show symptoms of chlorosis, followed by necrosis and senescence. Therefore, it is essential to use meshes in the cultivation of cut flowers such as lisianthus.

The gradations of tones in the kriging maps indicate bluish tones for less intense light energy and orange for greater intensity. In Figure 1a, it is possible to see that in the AM environment there was formation of islands with greater irradiance from the sides to the central region of the experimental site, with values between 0.22 and 0.20 W. m^{-2} .

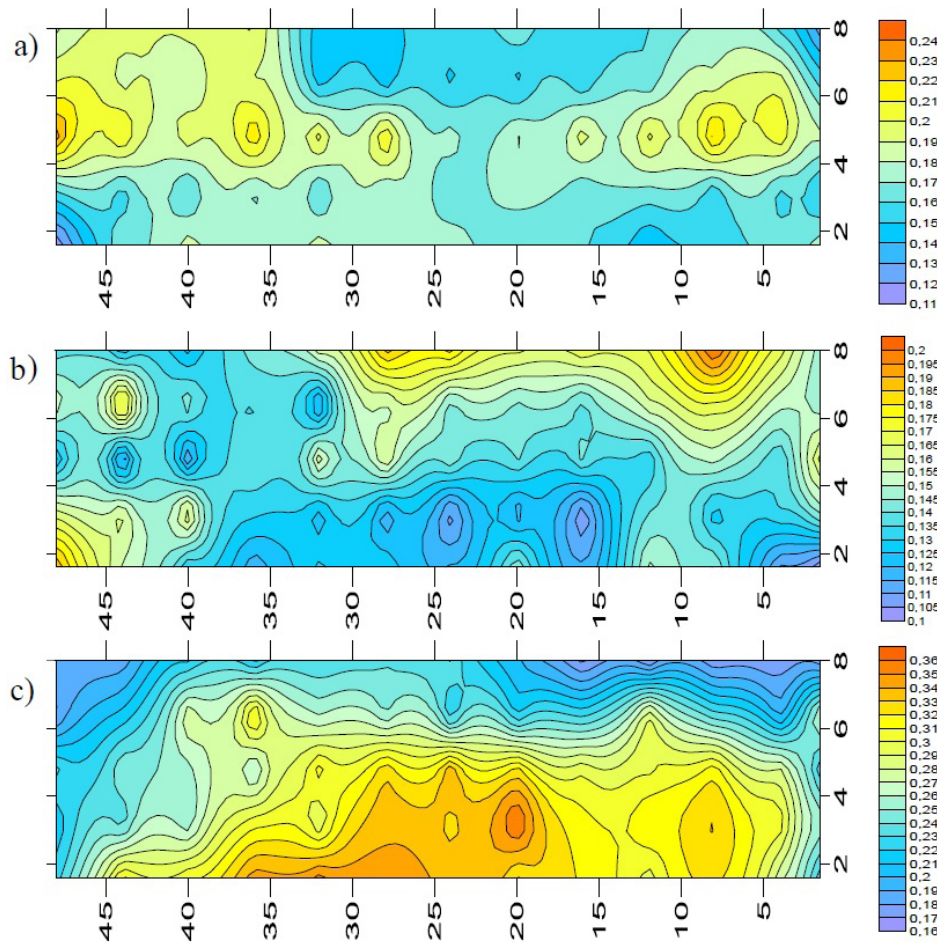
In the RM environment, Figure 1b, there was, in general, less intense light energy with a predominance of bluish tones in the longitudinal, in this region the energy values varied between 0.15 and 0.10 W. m^{-2} .

Figure 1c shows the irradiance in the WM environment, with orange stains in greater proportions when compared to the other kriging maps, the values varied between 0.34 and 0.28 W. m^{-2} , characterizing an energy flow in that environment superior when compared to other environments.

Regarding the observed in the present work, the intensity of solar radiation establishes microclimatological conditions, the temperature being directly proportional to the solar radiation, while humidity is inversely related (MEDEIROS; HOLANDA; FRANCE, 2018), justifying the observed in the WM environment.

From the summary of the analysis of variance, Table 3, it was found that the different environments significantly affected the number of buttons ($p < 0.01$) and the thickness of the stem ($p < 0.05$). Regarding the varieties studied, these significantly affected the diameter of buds, being highly significant for the others, except for the commercial size, which was significant at 5% ($p < 0.05$). Concerning the interaction of environments with varieties, this significantly affected ($p < 0.05$) the variable number of buttons. Variables that were not significant were neglected in subsequent analyzes.

Figure 1 – Kriging map representing the intensity of solar energy ($W m^{-2}$) in the environment using as a subcover a) aluminized mesh (AM), b) red mesh (RM) and c) without mesh (WM), Federal University of Ceará, São Benedito - CE, 2014



Source: Elaborated by the authors (2021).

Table 3 – Summary of the analysis of variance of the variables: button diameter (BD), number of buttons (NB), actual size (AS), height (H), commercial size (CS) and stem thickness (ST) of the varieties blue, white and rose evaluated in AM, RM and WM environments, Federal University of Ceará, São Benedito - CE, 2014

FV	GL	QM					
		BD	NB	AS	H	CS	ST
Environments	2	0.89 ^{ns}	1.93 ^{**}	90.32 ^{ns}	69.55 ^{ns}	217.65 ^{ns}	0.42 [*]
Varieties	2	0.93 ^{ns}	2.84 ^{**}	13,426 ^{**}	930.41 ^{**}	379.56 [*]	1.22 ^{**}
E x V	4	2.29 ^{ns}	0.87 [*]	53.44 ^{ns}	35.04 ^{ns}	72.03 ^{ns}	0.13 ^{ns}
Residue	18	0.96	0.26	40.30	25.00	105.59	0.07
CV (%)		17.06	17.47	10.67	9.23	19.39	5.75

Source: Elaborated by the authors (2021). ns not significant; ** significant at the 1% level; and * at the 5% probability level by the F test

The evaluation of the environment versus variety interaction, Table 4, showed that the

WM environment provided a higher average for the number of buttons of the Rose variety

in relation to AM and RM, and also in relation to the Blue and White varieties. And for these two, when evaluated separately, there was no statistical difference in the number of buttons in the different environments.

Almeida (2017), studied the Pink, White and Purple varieties of lisianthus in red, blue and control meshes, and for the variable number of buttons the varieties did not differ between them. The red mesh and control provided more buttons.

Vegetative meristems can be converted directly to floral meristems when the plant is induced to flower, this induction being given by internal and external factors. Among the external factors, the intensity of light radiation, the availability of water, the length of the day and the temperature stand out (TAIZ; ZEIGER, 2017).

From the excerpt above, it is understood that the Blue and White varieties had similar behavior in which the different environments had similar results, with no significant differences between them, and the Rose variety had better response to a greater amount of light energy provided by the environment WM and higher temperatures, which induced a greater amount of floral primordia in the cultivation and, therefore, a greater amount of buds per stem.

Table 4 – Comparison table of averages of the interaction between environments (aluminized mesh (AM), red mesh (RM) and without mesh (WM)) x varieties (blue, white and rose) for the variable number of flower buds (NB), Federal University of Ceará, São Benedito - CE, 2014

	Number of flower buds		
	Blue	White	Rose
AM	2.88 aA	2.47 aA	3.13 bA
RM	2.90 aA	2.03 aA	2.64 bA
WM	3.03 aB	2.58 aB	4.68 aA

Source: Elaborated by the authors (2021). Lower case letters represent the columns and upper case the lines. The means followed by the same letter do not differ statistically. The Tukey test was applied at the level of 5% probability.

The total length of the stem is represented by the H variable, the varieties Rose and Blue were statistically equal and had the highest averages, with 69 and 63.72 cm (TABLE 5).

The variable AS expresses the real possibility of the stem composing the bunch of flowers, as it considers the length of the open floral bud up to the base of the stem. The highest average, Table 5, was found in the Rose variety, with 62.82 cm, followed by the Blue variety, with 56.66 cm, and the lowest average was obtained for the White variety, with 42.96 cm (TABLE 5).

The commercial size analysis (CS) considers only the classification values of the bundles according to the size of the stem, with 50 cm, 60 cm or 70 cm. The Rose and Blue varieties reached the minimum size to be considered able to compose the pack, with average sizes of 59.16 cm and 53.63 cm. Furthermore, the White variety showed an inadequate value, 46.21 (TABLE 5).

Cantor *et al.* (2013) highlight that the genetic improvement originated varieties with different shades, sizes and shapes. Therefore, the variation in the size of the stems depends on the genetic characteristics of each of the varieties analyzed.

The criteria for the composition of the pack, whether the number of stems or length, are based on the requirements of the buyer and the decision of the producer, although Ibraflor recommends the stem's ability to compose the pack the size from 40 cm.

Regarding the thickness of the floral stem, the variety that showed the best performance was Rose, followed by Blue and the lowest average was obtained by White. For this same variable, there was no significant difference between the WM and AM environment, as the RM provided a lower mean for nail thickness (TABLE 5).

Almeida, Calaboni and Rodrigues (2016) studied the Snow White lisianthus variety in different light transmission meshes (blue, black, red and control) and found no significant difference between the environments studied for the stem diameter variable.

Ibraflor (2016) recommended that, in order to guarantee its support, the stem must have a thickness greater than 4 mm. Thus, all varieties, regardless of the environment, were within the quality standards required to adapt the pack.

Table 5 – Average values for the variables height of the floral stem (H), actual size (AS), commercial size (CS) and thickness of the floral stem (ST) in the blue, white and rose varieties, and for ESP in the varieties and environments with aluminized mesh (AM), red mesh (RM) and without mesh (WM), Federal University of Ceará, São Benedito - CE, 2014

	Averages			
	H	AS	CS	ST
Blue	63.72 a	56.66 b	53.63 ab	4.72 b
White	45.71 b	42.96 c	46.21 b	4.34 c
Rose	69.00 a	62.82 a	59.16 a	5.08 a
AM	-	-	-	4.85 a
RM	-	-	-	4.46 b
WM	-	-	-	4.83 a

Source: Elaborated by the authors. In the columns, the means followed by the same letter do not differ by 5% by the Tukey test; -: Variables that were not significantly affected by the studied environments.

Conclusion

The performance of the cut lisianthus varieties evaluated in this study, in general, did not receive increments for the use of meshes.

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