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Quality and growth of mangaba (*Hancornia speciosa*) seedlings according to the substrate and shading

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Abstract

The use of suitable substrates and growing environments are essential to produce high quality seedlings. This work evaluated shading levels and different substrates to produce mangaba seedlings. Growth environments with 0, 18, 35, and 50% shading were evaluated. In these environments, four substrates (S) were obtained from the combinations of soil (So), cattle manure (M), commercial substrate (CS), sand (Sa) and fine grain vermiculite (V), where: S1 = 0% So, 45% M, 20% CS, 20% Sa, 15% V, S2 = 15% So, 30% M, 20% CS, 20% Sa, 15% V, S3 = 30% So, 15% M, 20% CS, 20% Sa, 15% V, and S4 = 45% So, 0% M, 20% CS, 20% Sa, 15% V. For each growth environment, a completely randomized experimental design with five replications of five seedlings was adopted. The substrates S2 and S3 originated the best seedlings with the largest number of leaves, the largest dry mass of shoot, root, and total, and the highest Dickson quality index. The highest plants were obtained in the substrate S2. In the full sunlight environment, the conducted plants in S2 presented larger neck diameter. The environments with 0 and 18% of shading provided plants with larger leaves, larger aerial and total phytomass, and Dickson quality index. The environment in full sunlight promoted plants with a larger diameter. Therefore, it is recommended to produce seedlings on substrates S2 and S3 and in environments of 0 and 18% of shading.

Keywords: Cattle manure; *Hancornia speciose*, plant ambiance.
Abbreviations: S1, S2, S3 and S4_substrates, ESI_emergence speed index, PE_percentage of emergence, PH_plant height, SD_stem diameter, NL_number of leaves, SDM_shoot dry mass, RDM_root dry mass, TDM_total dry mass, DQI_Dickson quality index, DAS_days after sowing.

Introduction

The mangaba (*Hancornia speciosa*) belonging to the Apocynaceae family, is a species with a medium-size characteristic, and the fruit is native from Brazil, generally found in regions with a tropical climate. It presents aromatic, tasty, and nutritious fruits, with full acceptance of market, both in nature consumption and for the industries, besides, the plant exudes latex (Soares et al., 2006). It has aroused interest in the market, being essential the stage of production of seedlings, which will promote vigor the plant for field transplantation. Aiming to obtain vigorous seedlings of mangaba, it is necessary the use of suitable substrates because this interferes in the germinative process and the initial growth of the seedling. The importance of choosing the substrate for the production of quality seedlings is related to the capacity of variation of the physical, chemical and biological properties of the substrates, since the characteristics of structure, nutrition, aeration, and water retention capacity vary according to the material used, which may affect the initial growth (Silva et al., 2011).

The establishment of a forest plantation intended for the conservation of the species or commercial purposes is directly related to the quality of the seedlings. The success to obtain high quality seedlings, with desirable attributes, it is related to the shoot and root of the seedlings, which must be in equilibrium so that the seedlings have a high probability of survival and satisfactory growth in the field (Grossnickle and Macdonald, 2018). From this principle, the appropriate employing technologies must obtain high-quality seedlings. Studies that provide information to producers from the stage of seedling formation are essential since the use of quality seedlings will be reflected in the establishment of a productive plantation. For the formation of seedlings, several techniques that provide superior quality are fundamental, especially, the association between the growing environment and substrate. The substrate should have adequate chemical and physical properties, from alternative raw materials, to reduce production costs, and to provide plant support and adequate nutrition for root growing, favoring the initial development of the plant. Interacting with the substrates in the formation of high-quality seedling, the protected environment aims to provide micrometeorological conditions appropriate to the initial plant growing. Thus, the study of the type of environment and its level of shading aims to verify the ability of the species to adapt to different environmental conditions, such as the amount of solar radiation, temperature, humidity, as well as avoid or decrease the influence of strong winds, rains, pests or diseases. The production of seedlings of some species according to Salles et al. (2019) in protected environments may improve the quality of the seedlings by providing improvement of the micrometeorological conditions to which the plants are subjected during all seasons of the year. In a study with Croada (*Mouriri elliptic*), the authors found that quality seedlings were formed under black shading conditions, with substrate composition of up to 30% cattle manure and 40% vermiculite. As verified in research with mangaba (*Hancornia speciosa*), Arrua et al. (2016) reported that environments with a black screen and aluminized screen for seedling formation, and the authors did not recommend the use of substrates with more than 30% of cattle manure.

Studies with different protected environments and substrates were carried out with several fruit species, which may be native or exotic in the Cerrado region, such as the studies carried out by Silva et al. (2011) for the mangaba (Hancornia speciosa), Silva et al. (2018 a, 2018b) for the achachairu (Garcinia humilis), Costa et al. (2015) for the baru (Dipteryx alata Vog.), Salles et al. (2017) for the jambolan (Syzygium cumini), since these species present potential for commercial production, besides uses destined to the recovery of degraded areas, medicinal uses and in the culinary in general.

Studies with substrates that provide ideal conditions to obtain quality seedlings, and studies with the appropriate growing environment, for the plant to present its full physiological potential to produce high quality mangabeira seedlings are necessary. This work aimed to evaluate different levels of shading and substrates to produce mangaba (Hancornia speciosa) seedlings.

Results and discussion

Comparison of shading levels (Analysis of groups of experiments) and Variance analysis

Aiming to analyze the data, the different levels of shading (0, 18, 35 and 50%) were compared using the ratio between the largest and the smallest residual mean squares of the substrate analyzes (RMS_R). At the four levels of shading, emergence speed index (ESI), percentage of emergence (PE), plant height (PH), stem diameter (SD), number of leaves (NL), shoot dry mass (SDM), root dry mass (RDM), total dry mass (TDM), Dickson quality index (DQI) presented, respectively, the following values of the ratio 1.97; 1.44; 2.90; 3.73; 2.71; 2.66; 4.12; 2.32 and 4.58, demonstrating that all variables had a ratio lower than 7, that is, they allowed the analysis of groups of experiments and the comparison of growing environments (Table 3).

There was no interaction between the factors, shading levels, and substrates for the variables PH, NL, SDM, RDM, TDM. For the ESI and PE. Also, there was no significant difference between the levels of shading (Table 4).

Emergence of mangaba seedlings

For the emergence speed index, the emergence speed of the seedlings in substrates S1, S2 and S3 did not differ between the cultivation environments, while for the substrate S4, the environments with 18 and 50% of shading promoted a higher emergence speed of mangaba seedlings compared to the 35% and 0% shading environments. For the percentage of emergence, the S1, S2 and S3 substrates did not differ about the environments, but for the S4 substrate, the growing environments with 18 and 50% of shading promoted a higher percentage of emergence (Table 5).

Regarding substrates, both ESI and PE, in the environments with 18 and 50% shading, did not differ, while, in the environments with 0% and 35% shading, the substrate S4 did not favor the germination and emergence process. In general, in all environments, substrates S1, S2 and S3, which contained higher levels of bovine manure, promoted adequate conditions, such as good structuring and aeration for the germination and emergence process of mangaba seedlings, favoring both the emergence speed index (ESI) and the percentage of emergence (PE) (Table 5).

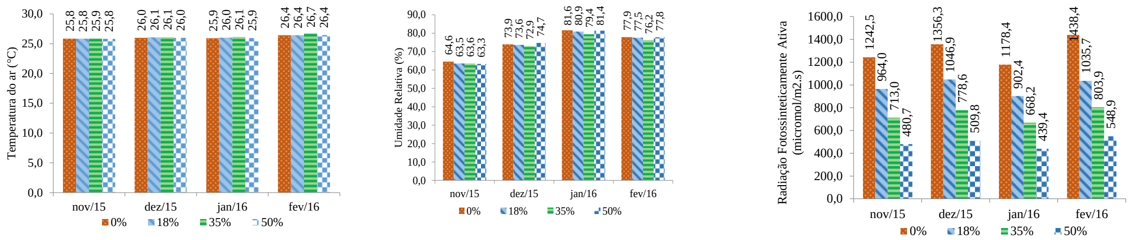
Number of leaves, plant height and phytomass of mangaba seedlings

The highest number of leaves was verified in the seedlings formed in the environments with the lowest percentage of shading. As well as for the variable PH, in which the largest seedlings were also obtained in the environments 0%, 18% and 35% of shading. The behavior of the mangaba seedlings in an environment with a higher percentage of shading or lower incidence of photosynthetically active radiation, is not beneficial for the initial growth, forming smaller seedlings, with a smaller number of leaves (Figure 1C). The substrate S2 (15% So, 30% M, 20% CS, 20% Sa, 15% V) favored the number of leaves and plant height (Table 6). For all dry mass evaluations, the substrate S2 (15% So, 30% M, 20% CS, 20% Sa, 15% V) and S3 (30% So, 15% M, 20% CS, 20% Sa, 15% V) promoted better conditions for the phytomass accumulation in all environments. The seedlings that presented the highest dry masses were those that grew in the environments with the lowest level of shading, 0% and 18% of shading, which presented the highest averages of photosynthetically active radiation (Figure 1C). It can be observed that even in full sunlight, the seedlings formed had high quality (Table 6).In this experiment, the substrates that had a proportion between 15 and 30% of bovine manure, originated the seedlings with larger phytomass. The results corroborated with the studies by Silva et al. (2011) that when analyzing substrates during the production of mangaba seedlings reported that the substrates with from 20% to 40% of bovine manure promoted greater growth in height, greater accumulation of dry mass of the aerial part and dry mass of the root system. As verified by Silva et al. (2018a) for achachairu, an exotic fruit species with good performance in the cerrado, which presents a positive response in the seedlings production phase, to substrates that contain an adequate proportion of bovine manure.For the growth variables mentioned above, the substrate S2 (15% So, 30% M, 20% CS, 20% Sa, 15% V), showed in all evaluations to be the most adequate to conduct seedlings of mangaba. The substrate S1 that had 45% of cattle manure was not favorable to growth. It is essential for the formation of the seedlings that the substrate presents around 15 to 30% of organic matter from cattle manure. The same was verified by Arrua et al. (2016) that do not recommend the

Table 1. Result of the chemical analysis of cattle manure (M) used in the composition of the substrates. Cassilândia-MS, 2016.

N	P_2O_5	K_2O	Ca	Mg	S	H-65ºC	C
		--	** % in natura	--			
0.9	0.3	0.1	0.3	0.1	0.2	2.0	11.0
Na	Cu	Fe	Mn	Zn	C/N	pH	O.M.
	------------------**mg/kg in natura	----------------				$CaCl_2$	** % in natura
624	18	12,103	204	53	12/1	5.3	20.0

H = humidity; O.M. = organic matter; C/N = carbon and nitrogen ratio.



(A) (B) (C)

Fig 1. Air temperature (A), Relative humidity of the air (B) and photosynthetically active radiation (C) recorded in the cultivation and external environments during the experimental period.

Table 2. Physicochemical characteristics of the soil used in the composition of the substrates. Cassilândia-MS, 2016.

pH	------- $cmol_c\ dm^{-3}$ -------			$mg\ dm^{-3}$		$cmol_c\ dm^{-3}$	Particle size ($g\ kg^{-1}$)		
$CaCl_2$	Ca	Mg	Al	K	$P_{Mehlich-1}$	CEC	Clay	Silt	Sand
5.8	6.10	2.20	0.01	165	1.8	11.1	110	50	840
$g\ dm^{-3}$		--------- $mg\ dm^{-3}$ Mehlich-1---------					$g\ dm^{-3}$		%
S	B	Cu	Fe	Mn	Zn	Na	O.M.	O.C.	V
4.8	0.24	0.4	14	90.5	1.7	n.d.	35.6	20.6	78.4

O.M.: organic matter. O.C. = organic carbon. V: soil base saturation. n.d.: not detected.

Table 3. Ratio between the largest and the smallest residual mean squares of the substrate analyzes (RMS_R) for the emergence speed index (ESI), percentage of emergence (PE), plant height at 118 (DAS) (PH), stem diameter (SD), number of leaves (NL), shoot dry mass (SDM), root dry mass (RDM), total dry mass (TDM) and Dickson quality index (DQI) of mangaba seedlings in different environments and substrates. Cassilândia-MS, 2016.

Shading levels	ESI	PE	PH	SD	NL
0%	0.00749	0.06934	3.52189	0.25267	3.50789
18%	0.00477	0.05569	6.97034	0.10721	2.88775
35%	0.00870	0.08003	3.48238	0.06781	1.29594
50%	0.00442	0.06093	2.39953	0.10019	1.65081
RMS_R	1.97	1.44	2.90	3.73	2.71
Shading levels	SDM	RDM	TDM	DQI	
0%	0.15304	0.00849	0.20388	0.00286	
18%	0.11318	0.00575	0.14496	0.00118	
35%	0.05743	0.00964	0.08783	0.00122	
50%	0.11650	0.00234	0.13724	0.00063	
RMS_R	2.66	4.12	2.32	4.58	

Table 4. Variance analysis for emergence speed index (ESI), percentage of emergence (PE), plant height (PH), stem diameter (SD), number of leaves (NL), shoot dry mass (SDM), root dry mass (RDM) and total dry mass (TDM) and Dickson quality index (DQI) at 118 days after sowing of mangaba seedlings in different growing environments and substrates. Cassilândia-MS, 2016.

Cause of variation	ESI	PE	PH	SD	NL
Environments (E)	Ns	ns	*	**	**
Substrates (S)	**	**	**	**	**
E x S	**	*	ns	**	ns
CV (%)	26.91	25.20	10.13	10.39	8.54
Cause of variation	SDM	RDM	TDM	DQI	
Environments (E)	**	**	**	**	
Substrates (S)	**	**	**	**	
E x S	Ns	ns	ns	*	
CV (%)	18.37	20.80	17.26	18.27	

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

Table 5. Emergence speed index (ESI) and percentage of emergence (PE) at different shading levels and substrates, Cassilândia-MS, 2016.

Emergence speed index (ESI)				
Substrates	Shading levels			
	0%	18%	35%	50%
S1	0.35 aA	0.33 aA	0.40 aA	0.29 aA
S2	0.26 aA	0.34 aA	0.31 aA	0.33 aA
S3	0.28 aA	0.19 aB	0.22 aB	0.31 aA
S4	0.22 bA	0.30 aA	0.18 bB	0.35 aA
CV (%) = 26.91				
Percentage of emergence – PE				
Substrates	Shading levels			
	0%	18%	35%	50%
S1	84.00 aA	76.00 aA	88.00 aA	72.00 aA
S2	62.00 aB	78.00 aA	72.00 aA	76.00 aA
S3	66.00 aB	46.00 aB	54.00 aB	76.00 aA
S4	52.00 bB	74.00 aA	44.00 bB	84.00 aA
CV (%) = 25.20				

CV = Coefficient of Variation, Means followed by the same uppercase letter at the columns and lowercase letter at the lines belong to the same group by Scott Knott's test at 5% probability. S= Substrates, S1 = 0% So, 45% M, 20% CS, 20% Sa, 15% V, S2 = 15% So, 30% M, 20% CS, 20% Sa, 15% V, S3 = 30% So, 15% M, 20% CS, 20% Sa, 15% V, and S4 = 45% So, 0% M, 20% CS, 20% Sa, 15% V.

Table 6. Number of leaves (NL), plant height (PH), shoot dry mass (SDM), root dry mass (RDM) and total dry mass (TDM) of mangaba seedlings at different shading levels and substrates, Cassilândia-MS, 2016.

Shading levels	NL	PH (cm)	SDM (g)	RDM (g)	TDM (g)
0%	18.61 a	20.18 a	1.90 a	0.41 b	2.31 a
18%	18.50 a	20.59 a	2.05 a	0.45 a	2.51 a
35%	17.69 b	20.44 a	1.69 b	0.38 b	2.08 b
50%	16.72 b	18.69 b	1.56 b	0.30 c	1.86 b
Substrates	NL	PH (cm)	SDM (g)	RDM (g)	TDM (g)
S1	18.17 b	22.01 b	1.80 b	0.40 b	2.20 b
S2	19.52 a	23.53 a	2.36 a	0.48 a	2.85 a
S3	19.53 a	22.30 b	2.23 a	0.45 a	2.68 a
S4	14.31 c	12.06 c	0.81 c	0.21 c	1.03 c
CV (%) =	8.54	10.13	18.37	20.80	17.26

CV = Coefficient of Variation, Means followed by the same uppercase letter at the columns and lowercase letter at the lines belong to the same group by Scott Knott's test at 5% probability. S= Substrates, S1 = 0% So, 45% M, 20% CS, 20% Sa, 15% V, S2 = 15% So, 30% M, 20% CS, 20% Sa, 15% V, S3 = 30% So, 15% M, 20% CS, 20% Sa, 15% V, and S4 = 45% So, 0% M, 20% CS, 20% Sa, 15% V.

Table 7. Stem diameter (SD) and Dickson quality index (DQI) of mangaba seedlings at different shading levels and substrates, Cassilândia-MS, 2016.

Stem diameter (SD-mm)				
Substrates	Shading levels			
	0%	18%	35%	50%
S1	3.86 aB	3.58 aA	3.09 bB	3.53 aA
S2	5.08 aA	3.88 bA	3.98 bA	3.46 cA
S3	4.09 aB	3.65 bA	3.73 bA	3.33 bA
S4	3.65 aB	2.42 bB	2.16 bC	2.38 bB
CV (%) = 10.39				
Dickson quality index (DQI)				
Substrates	Shading levels			
	0%	18%	35%	50%
S1	0.22 aB	0.22 aB	0.17 bB	0.18 bA
S2	0.32 aA	0.30 aA	0.24 bA	0.18 cA
S3	0.28 aA	0.27 aA	0.22 bA	0.18 cA
S4	0.13 aC	0.12 aC	0.12 aC	0.10 aB
CV (%) = 18.27				

CV = Coefficient of Variation, Means followed by the same uppercase letter at the columns and lowercase letter at the lines belong to the same group by Scott Knott's test at 5% probability. S= Substrates, S1 = 0% So, 45% M, 20% CS, 20% Sa, 15% V, S2 = 15% So, 30% M, 20% CS, 20% Sa, 15% V, S3 = 30% So, 15% M, 20% CS, 20% Sa, 15% V, and S4 = 45% So, 0% M, 20% CS, 20% Sa, 15% V.

formation of mangaba seedlings in a substrate containing 30% or more of cattle manure in mixture with other materials used. The production of seedlings, according to the shading levels, shows that the initial growth and quality of the seedlings were higher in environments with lower levels of shading, with 0% and 18% shading. Similar averages of PH, NL, SD, and SDM were verified by Arrua et al. (2016), who evaluated the conduction in two protected environments, both 50% of shading. Black screen and the aluminized screen are indicated to form mangaba seedlings, so it is emphasized that the species presents great ease of adaptability to different environmental conditions (Arrua et al., 2016) (Fig 1A, 1B and 1C).

Stem diameter and Dickson quality index of seedlings

Stem diameter had higher averages, collected in the seedlings formed in the full sunlight, with 0% shading. In full sunlight, the seedlings conducted in the substrate S2 presented a larger diameter, whereas in the environments with 18% and 50% of shading, only the substrate S4 did not favor growth in diameter, already in the environment with 35% of shading, substrates S2 and S3 provided the largest growth of stem diameter of the seedlings (Table 7).
During the production of seedlings, some growth characteristics must be achieved, such as an adequate relation between height and stem diameter, because the plant when transplanted cannot fall. However, the seedlings must have suitable distribution between shoot and root system, and according to some authors, such as Arrua et al., (2016) it is essential that the root system be robust and well distributed, presented according to some authors as Arrua et al. (2016), Sanches et al. (2017), Silva et al. (2018b), Salles et al. (2017) higher Dickson quality indexes, which encompass all growth relationships. It was observed, for the IQD, that the seedlings formed in the substrates S1, S2 and S3, in the 0% and 18% shading environments had the highest quality indices, while those formed in the substrates S4 did not differ according to the environments. In all growing environments, the substrates S2 and S3 stood out because they provided optimal conditions for growth, and formation of quality seedlings (Table 7). For the formation of some fruit species, it is essential that it be supplied in the composition of the substrates, sources of organic matter, and in some studies it is observed that the cattle manure is suitable for the formation of seedlings, as verified by other authors such as Silva et al. (2011) and Arrua et al. (2016) for mangaba, Silva et al. (2018a) for Achachairu, and Costa et al. (2015) for baru. As verified by the obtained results, it is observed that the mangaba seedlings formed in the environments with lower level of shading, presented high quality, with higher averages in the growth variables, revealing the rusticity of the species in high luminosity conditions (solar radiation), mainly in summer, as can be seen in Figure 1.

Materials and methods

Localization and experimental characterization

Experiments with the formation of mangaba seedlings at different shading levels and substrates were conducted at Mato Grosso do Sul State University (UEMS), in Cassilândia - MS, Brazil (19º07'21" S, 51º43'15" W and altitude of 516 m), from October 2015 to February 2016. The site presents latitude 19º07'21 "S, longitude 51º43'15" W and altitude of 516 m (Automatic Station CASSILANDIA-A742). According to Köppen classification, the region has Rainy Tropical Climate (Aw), characterized by being warm and humid, with two defined seasons, rainy in summer and dry in winter.

Plant Material and Growth Conditions

The growing environments were: 1) seedling exposed to full sunlight with 0% shading, in full sunlight (A1- 0% of shading); the others were shading screenhouse with a monofilament screen in all its extension (Sombrite®), differing in the level of shading and the area, 2) shading screenhouse with 18% of shading (A2- 18% of shading) and 3) shading screenhouse with 35% of shading (A3- 35% of shading), both with a wooden structure, with 6.00 m wide, 6.00 m long length and 2.50 m high, closing at 90 ° inclination, and 4) shading screenhouse with 50% of shading (A4- 50% of shading), with galvanized steel structure, with 8.00 m wide width by 18.00 m long length and 3.50 m high, closing at 45° inclination.
The propagation mode was by seeds. Sowing was performed on October 30th, 2015 with two seeds per polyethylene bags (15.0 x 25.0 cm), 1.8 liters, at from 1 to 3 cm depth. The polyethylene bags were filled with substrates (S) resulting from the combinations (%) of soil (So), cattle manure (M), commercial substrate (CS), sand (Sa) and fine grain vermiculite (V), with combinations that ranged only the contents of cattle manure and soil, from 0 to 45%, the other raw materials remained stable. The combinations were as follows, S1 = 0% So, 45% M, 20% CS, 20% Sa, 15% V, S2 = 15% So, 30% M, 20% CS, 20% Sa, 15% V, S3 = 30% So, 15% M, 20% CS, 20% Sa, 15% V, and S4 = 45% So, 0% M, 20% CS, 20% Sa, 15% V, arranged in completely randomized experimental design, with five replications of five seedlings each.
The compounds that constituted the substrates were purchased in the region of Cassilândia-MS. The commercial substrate used was Bioplant Nature (Bioplant Agrícola Ltda., Nova Ponte, MG, Brazil), composed of coconut fiber, rice husks, pine bark, and nutrients. The commercial substrate, vermiculite, and sand were purchased from commercial companies. Cattle manure was subjected to aerobic composting for 45 days in a closed shed, being stirred and moistened every two days. The soil was collected from the 0 to 30 cm depth layer in an Arenic Entisol with 110 g kg–1 of clay, 50 g kg–1 of silt, and 840 g kg–1 of sand. The soil and cattle manure were chemically characterized, as shown in Tables 1 and 2. The water reposition was carried out daily with a watering can, in order to maintain the water content of the substrates close to the field capacity.

Growth measurement and seedling quality indexes

The emergence started at 19 days after sowing (DAS). Between 19 and 27 DAS, data were collected to analyze the emergence speed index (ESI) and the percentage of emergence (PE). Plant height (PH), stem diameter (SD), number of leaves (NL), shoot dry mass (SDM), and root dry mass (RDM) were collected at 118 DAS. From this data, the total dry mass (TDM) and the Dickson quality index (DQI) were determined.
The plant height was measured using a millimeter ruler, measuring the distance from the soil surface to the plant apex, the stem diameter was measured with a digital caliper (mm). The number of leaves was measured by counting. The root and shoot dry mass (g) were obtained after drying in a

forced air circulation oven at 65 ° C until reaching the constant mass. The mass was measure in analytical balance. The total dry mass was obtained by the sum of root and shoot dry mass.
In the growing environments were monitored the air temperature (ºC), the relative humidity of the air (%), the photosynthetically active radiation (µmol.m^{-2}.s^{-1}), using the device APOGEE MQ-200. Data were collected from November 2015 to February 2016 (Figure 1A, 1B, and 1C).

Experimental Design and Statistical Analysis

Each shading level was considered an experiment because there were no replications. Within the environment, the experiment was conducted in a completely randomized experimental design, in a 4 x 4 factorial scheme (four shading levels x four substrates) with five replications of 5 seedlings each. For comparison of shading levels, we used the analysis of groups of experiments, which evaluated the relationship between the largest and the smallest square of the residual of the 4 x 4 factorial scheme. The environments were evaluated by the joint analysis (Banzatto & Kronka, 2013), composing a factorial scheme 4 x 4 (four levels of shading x four substrates). Subsequently, the data were submitted to the variance analysis (F test), and the averages were grouped by the Scott-Knott test, at 5% probability for the substrates and growing environments, using the Sisvar software.

Conclusion

The substrates containing between 15 e 30% de cattle manure, as the substrates, S2 (15% of soil and 30% of cattle manure, 20% of commercial substrate, 20% of sand and 15% of fine grain vermiculite) and S3 (30% of soil, 15% of cattle manure, 20% commercial substrate, 20% of sand and 15% of vermiculite), provided a favorable condition for the formation of seedlings, favoring the emergence and the initial growth.
The growing environments with the lowest percentage of shading formed quality seedlings, being recommended to produce the seedlings in full sunlight or a shading screenhouse with 18% of shading.

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