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PROTECTED ENVIRONMENTS AND SUBSTRATES FOR MANGABEIRA SEEDLINGS (*Hancornia Speciosa* Gomez) PRODUCTION

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ABSTRACT: Mangabeira is a native fruit tree from Brazil, which provides a delicious fruit to taste and beneficial to health, whose information about the seedlings production will assist the entire productive chain of this important species. The aim of this research was to evaluate protected environments and substrates compositions in the formation of mangabeira seedlings. For this, two greenhouses with different screens were used, the first covered with aluminized thermo-reflective screen of 50% shading and the second with black screen of 50% shading. Inside the environments, were tested substrates derived from combinations of various proportions of bovine manure (M), soil (S), medium vermiculite (MV), super fine vermiculite (FV) and fine sand (FS). For each environment of cultivation was adopted a completely randomized design to evaluate the substrates, with five replicates of eight plants. The environments were compared by analysis of experiments groups. The results showed that both protected environments are suitable for mangabeira seedlings. In the aluminized screen is indicated for the formation of seedling in the substrate with 20% M + 30% S + 10% MV + 30% FV + 10% FS while in the black screen is indicated for seedlings in the substrate with 10% M + 30% S + 10% MV + 10% FV + 40% FS and with 10% M + 30% S + 40% MV + 10% FV + 10% FS.

KEYWORDS: *Hancornia speciosa*, protected environment, climatic factors, vermiculite, sand.

INTRODUCTION

In the ‘cerrado’ vegetation there is a wide variety of native fruit that is increasingly threatened by the advance of agriculture and extraction, which can cause the extinction of many species, even before they are discovered and studied. One of the native fruit that has aroused the interest is mangabeira (*Hancornia speciosa* Gomez). It is a native tree from Brazil, of mid-size, that can reach 15 meters of height, tropical climate, belonging to the Apocinaceae family, which produces an aromatic fruit with high nutritional value, and it is consumed *in natura* (LORENZI, 1998) or processed into ice cream and pulp for juice.

Among the stages of mangabeira production, it can be highlighted the seedlings production, which the implantation quality of an orchard is due to the offered ambience and substrate type used because they directly interfere in the germination, growth process, root development, water retention, aeration, among others. The substrate must gather physical and chemical characteristics that promote moisture retention and nutrient availability, so they meet the plant’s needs (PAIVA SOBRINHO, 2010).

The substrates are pure materials or mixture of various materials, and should have organic or inorganic nutrient source, as well as light and porous material to obtain appropriate physical and chemical properties to the needs of each species. Allying and interacting with the substrates, another important factor is the use of environments to protect the seedlings in the early stage development, since in this stage the seedlings are sensitive to strong winds, high radiation, pests and diseases attack, so the protective structures with screens or polyethylene films aim to minimize the negative effects that impair the proper plant growth. Studies with protected environments for cultivation of ‘Cerrado’ fruit seedlings, native or occurring, were developed by SANTOS et al. (2011) and COSTA et al. (2011) with ‘jatobazeiro-do-cerrado’(*Hymenaea stigonocarpa* MART), COSTA et al.

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(2012a) with tamarind (*Tamarindus indica*), OLIVEIRA et al. (2014 a,b) and COSTA et al. (2012b) with 'baruzeiro'(*Dipteryx alata*) and SASSAQUI et al. (2013) with 'jenipapeiro' (*Genipa Americana)*.

The fruit cultivation is important in the country, in the specific case of mangabeira because of its widespread use and benefits, allied with little information in the literature, mainly related to the production of good quality seedlings. Thus, the aim was to evaluate two protected environments with different screens and substrates compositions in the formation of mangabeira seedlings (*Hancornia speciosa* Gomez).

MATERIAL AND METHODS

The experiments of mangabeira (*Hancornia speciosa* Gomez*)* seedlings formation in different substrates and protected environments were carried out in the State University of Mato Grosso do Sul (UEMS), Cassilândia University Unit (UUC), located at Cassilândia municipality, with latitude of 19º07'21"S, longitude of 51º43'15"W and altitude of 516 m (CASSILANDIA-A742 automatic station). According to the Köppen climate classification presents Rainy Tropical Climate (Aw), with rainy summer and dry winter (winter rainfall below 60 mm).

Two types of protected environment were used:

- (A1) Agricultural greenhouse, of galvanized steel structure, with 8.00 m of wide by 18.00 m of length, with a height of 4.00 m, covered with aluminized thermo-reflective screen of 50% shading at 3.3 m, and side closures at 90 degree angle with black screen of 50% shading.

- (A2) Agricultural greenhouse, of galvanized steel structure, with 8.00 m of wide by 18.00 m of length, with a height of 3.50 m, covered with black screen of 50% shading and side closures at 45 degree angle with the same screen.

The slopes of 90° (A1) and 45º (A2) of the side screens are only constructive details of the protected environment by specialist companies, and they did not constitute the study aim.

The mangaba propagation was done by seeds, which were collected near the Cassilândia Unit in fruit maturation period (November 2013).The seeds were sown in polythene bags (15.0 x 25.0 cm) of 1.8 liters, using the substrates mixed with cattle manure (M), soil (S), medium vermiculite (MV), super fine vermiculite (FV) and fine sand (FS), and the substrates combinations are shown in Table 1.

TABLE 1. Substrates containing various proportions of cattle manure (E), soil (S), medium vermiculite (MV), super fine vermiculite (FV) and sand (FS). Cassilândia-MS, 2013-2014.

Substrates	M (%)	S (%)	MV (%)	FV (%)	FS(%)
S1	50	30	10	10	0
S2	40	30	10	10	10
S3	30	30	10	10	20
S4	20	30	10	10	30
S5	10	30	10	10	40
S6	50	30	10	0	10
S7	30	30	10	20	10
S8	20	30	10	30	10
S9	10	30	10	40	10
S10	50	30	0	10	10
S11	30	30	20	10	10
S12	20	30	30	10	10
S13	10	30	40	10	10

The sowing was held on 11/16/2013, by placing three seeds per container, which was later carried out the thinning, leaving only one plant. The emergence was observed at 22 days after the sowing (DAS).

Soil and manure substrates were chemically characterized as shown in Tables 2 and 3.

TABLE 2. Chemical characteristics analysis of cattle manure (M) used in the preparation of substrates. Cassilândia-MS, 2013-2014.

N	P_2O_5	K_2O	Ca	Mg	S	Hu	Total-OM	Total-C
--Natural Percentage --								
0.7	0.5	0.1	1.3	0.1	0.1	32	12	7
Na	B	Cu	Fe	Mn	Zn		C/N (total)	
----------------natural $mgKg^{-1}$---------------------							Natural	
462	39	15	6018	132	87		10	6.6

Hu – humidity; OM = organic matter; C/N = carbon and nitrogen relation.

TABLE 3. Chemical characteristics analysis of soil (S) used in the preparation of substrates. Cassilândia-MS, 2013-2014.

pH	$Cmol.dm^{-3}$			$Mg.\ dm^{-3}$(ppm)		Cmolc.	Texture (gdm^{-3})		
$CaCl_2$	Ca	Mg	Al	K	P(mel)	CEC	Clay	Silt	Sand
4.1	0.30	0.20	1.19	31	3.1	4.7	150	25	825
$mmdm^3$ (ppm)		Micronutrients $mg.dm^{-3}$(ppm), Mehlich 1					$g\ dm^{-3}$		%
S	B	Cu	Fe	Mn	Zn	Na	M.O	C.O	Base Sat.
1.3	0.29	0.7	104	25.3	0.4		13.7	7.9	12.4

The manure was purchased on local slaughterhouse, which was revolved every other day for a period of 45 days in a covered place before deployment. The composting procedure was carried out in windrows, moistened periodically and revolved every two days (NUNES, 2009).The settling time (maturity) of the manure depends on the initial carbon/nitrogen ratio (C/N) and other chemical and physical characters (KIEHL, 2004).Researchers emphasize that after maturation the C/N ratio is from 15/1 to 30/1 (VALENTE et al., 2009). In the present study, the C/N ratio was of 10, therefore the manure was matured and ready to use as substrate.

Underground soil collected in the university area was used. The vermiculite and the fine sand were purchased from commercial companies. The irrigation was done daily with watering can, always trying to do not soak the substrate, keeping in good condition for the seedling development. It was found nutritional deficiency, so was carried out nutrients application, by foliar via, on 02/27/2014, for all treatments, with no difference in the dose applied among the treatments.

In the period between 12/08/2013 and 12/19/2014, data for the emergence speed index analysis (ESI), the emergence percentage (EP) and the emergence average time (EAT) were recorded.

At 30, 60 and 90 days after the emergence (DAE), which correspond to 52, 82 and 112 days after sowing (DAS), plant height data (PH) and leaves number (LN) were collected.

At 90 DAE, was also collected the leaf chlorophyll index (CI), the stem diameter at 5 cm of the cervical height (SD), the shoot dry matter weight (SDM) and the system root dry matter weight (RDM).

From these data were determined the total dry matter (TDM), the height and stem diameter ratio (HSDR), shoot and root dry matter (RDM), the height and shoot dry mass^{-1} relation (HSDMR) and Dickson quality index (DQI):

$$DQI = \frac{TDM(g)}{\frac{PH(cm)}{SC(mm)} + \frac{SDM(g)}{RDM(g)}}$$

The seedling height was measured from the base of the substrate to the seedling apex, with the aid of a ruler (cm) and the diameter measured with a digital pachimeter (mm). The root and shoot dry matter were obtained by drying the plants in forced air circulation oven at 65ºC until constant mass and then weighed using precision scales of 0.001 g. The total dry mass was obtained by the sum of the shoot and root system dry mass.

Inside the protected environments, it was monitored air temperature (°C), the air relative humidity (%), the global solar radiation (W m^{-2}), and the total and diffuse photosynthetically active radiation (µmol m^{-2} s^{-1}).

The measurements of micrometeorological parameters inside the protected environments (greenhouses) were carried out from specific sensors, coupled to a GP2 Data Logger, Delta-T Devices, installed in the environment geometric center. The system was programmed to perform readings at intervals of 10 seconds, with averages of every minute. For the radiations, the daily average was calculated from 8 am to 6 pm.

For the external environment, the air temperature, air relative humidity and solar radiation values were acquired from the automatic platform of data collection in Cassilândia, A742, from INMET-SONABRA. For the external environment, it was not possible to get the active photosynthetically radiation, because the platform does not provide such data. The data were collected from February 3rd to March 8th, 2014 due to the equipment availability.

TABLE 4. Average temperature (°C), relative humidity (%), solar radiation (W m^{-2}), total photosynthetically active radiation (µmol.m^{-2}.s^{-1}) and diffuse photosynthetically active radiation (µmol.m^{-2}.s^{-1}). Cassilândia-MS, 2013-2014.

	T ma	T me	T mi	RH ma	RH me	RH mi	GR ma	GR me	GR mi
A1	36.5	25.2	19.2	99.9	71.0	22.9	912.0	187.9	2.0
A2	37.8	25.4	18.2	99.7	72.7	23.2	626.0	205.5	2.0
Ex	36.8	25.4	18.8	96.0	70.8	22.0	1146.7	497.4	3.7
	PARt ma	PARt av	PARt mi	PARd ma	PARd av	PARd mi			
A1	1946.0	413.77	3.0	596.0	166.18	3.0	-	-	-
A2	1272.0	404.62	4.0	502.0	198.75	3.0	-	-	-

A1 - aluminized screen; A2 = black screen; Ext = external; T = air temperature (°C); RH = Relative humidity (%); GR = global solar radiation (W m^{-2}); PARt = Total photosynthetically active radiation (µmol m^{-2} s-1); PARd = diffuse photosynthetically active radiation (µmol m^{-2} s^{-1}); ma = maximum; av = average; mi = minimum

The data were submitted to variance analysis (F test) and the averages were compared by the Scott-Knott test at 5% probability for the substrates and by the F test for the cultivation environments, with Sisvar software (FERREIRA, 2010).Because there is no repetition of cultivation environments, each one was considered an experiment. For each cultivation environment, were adopted a completely randomized design to evaluate substrates with eight repetitions of five seedlings. The environments were evaluated by experiments groups' analysis (BANZATTO & KRONKA, 2013).

RESULTS AND DISCUSSION

In Table 5 are reported the results to the emergence speed index (ESI), emergence percentage (EP) and emergence average time (EAT) of mangabeira in different protected cultivation environments and substrates.

It was verified the emergence at 22 days after sowing (DAS), corroborating with the results of SILVA et al. (2009) that found at 20 DAS. In the black screen, the S8 and S9 substrates, with 40 and 50% of vermiculite in their compositions, that added to 10% of sand, totaled 50 and 60% of inert and porous material on the substrate (Table 1), verified the largest ESI (Table 5), as well as in the aluminized screen, the S9 and S12 substrates because these substrates had favorable physical structure to the seedlings emergence. In S8 and S9 substrates (aluminized screen), the ESI results of 2.34 and 2.30 plants per day, respectively, were lower than those observed by SILVA et al. (2009) that found ESI of 7.54 (Table 5).

In the S4 and S10 substrates (in the A1 environment; aluminized screen), as in the S10 and S11 substrates (A2 environment; black screen) were obtained low values of ESI and EP (Table 5).It was observed in the S10 substrate, in both environments, low emergence of mangabeira because this substrate showed high percentage of cattle manure (50%) and low amounts of vermiculite (10%) and sand (10%), forming only 20% of inert porous material (Table 1), which theoretically are material more favorable to emergence. It has been observed that the environment influences the ESI variable because in general the best results were obtained in the aluminized screen (Table 5).

As for the EP variable, the substrates over 40% of porous material such as S8, S9 and S13 in the aluminized screen and S7, S8, S9 and S12 in the black screen, showed better results, reaching 68.3% in the aluminized screen and 55% on the black screen (Table 5). For 'baruzeiro', a Cerrado species, OLIVEIRA et al. (2014b) found EP of 67.23% for the black screen and 65.16% for the aluminized screen, while MOTA et al. (2012) found 75% of emergence to black screen with 50% shading for the same species. In summary, it was found that substrates containing larger amount of organic matter have provided a lower percentage of emergence (Table 5), as verified by OLIVEIRA et al. (2014b) and COSTA et al. (2012b). The use of organic matter in addition to providing nutrients also can raise the pH, as evidenced by ARTUR et al. (2007), which may have interfered in the mangabeira emergence in substrate with high amounts of manure in this study because the species is adapted to more acid soils.

In this study the EAT to mangabeira was around 28.82 days, but in the literature it was not found data to compare this variable with the same species. For other Cerrados species, the EAT results found by SCALON & JEROMINE (2013) with *Eugenia pyriformis* were 47 days and NEVES (2011) for 'uvaia' (*Eugenia pyriformis* Camb) was 66 days.

TABLE 5. Emergence speed index (ESI), emergence percentage (EP) and emergence average time (EAT) of mangabeira in different protected environments and substrates. Cassilândia-MS, 2013- 2014.

Substrates	ESI (Days)		EP (%)		EAT (Days)	
	Aluminized screen	Black screen	Aluminized screen	Black screen	Aluminized screen	Black screen
S1	1.88 bA	2.20 aA	49.2 bA	55.0 aA	27.81 aA	27.74 aA
S2	1.32 cB	1.85 aA	35.8 cB	50.1 aA	27.93 aA	27.78 aA
S3	1.45 cA	1.09 cA	41.8 bA	32.5 bA	28.08 aA	28.12 aA
S4	0.64 dB	1.20 cA	20.0 cB	34.2 bA	28.44 aA	28.02 aA
S5	1.73 bA	0.69 dB	46.7 bA	22.5 cB	27.77 bB	28.57 aA
S6	1.50 cA	0.81 dB	42.5 bA	22.5 cB	28.07 bA	28.20 aA
S7	1.20 cA	1.37 bA	32.5 cA	44.2 aA	27.86 bA	28.40 aA
S8	2.34 aA	1.48 bB	56.7 aA	41.7 ab	27.65 aA	27.88 aA
S9	2.30 aA	1.92 aA	63.3 aA	46.7 ab	27.99 aA	27.65 aA
S10	0.92 dA	0.47 dA	28.3 cA	17.5 cA	28.19 bB	28.82 aA
S11	1.50 cA	0.62 dB	45.0 bA	24.2 cB	28.09 bA	28.63 aA
S12	1.48 cA	1.90 aA	40.8 bA	47.5 aA	27.98 aA	27.82 aA
S13	1.91 bA	1.25 cB	51.2 aA	35.8 bB	27.85 bA	28.25 aA
CV (%)	33.58		20.95		2.04	

*Uppercase letters in the same rows and lowercase in columns, for each parameter, do not differ from each other by the Scott-Knott test for the substrates and by the F test for cultivation environments, at 5% probability.

The stem diameter is the important parameter in seedling quality because if the plant does not have adequate thickness and has high height the tipping of the seedling can occur after field planting. The seedlings of S5 and S8 substrates showed diameters greater than those from the other substrates in both environments, and the ones from S13 only in the black screen (Table 6). It was noted greater developments of stem diameter when using mixtures with porous and inert materials, these results are similar to those found by CARVALHO FILHO et al. (2003) in ‘jatobazeiro’ seedlings. These results at 112 DAS, even at 5.0 cm above the stem, are much higher than those found by SILVA et al. (2009), who obtained for stem diameter 2.89 mm and SILVA et al. (2011) 2.19 mm, because, on average, in this study was verified values of 3.89 mm (S8 in A1) and 3.88 mm (S13 in A2).

For substrates with larger diameters (S5 and S8) the cultivation environments were similar to the stem diameter, but for the S13 substrate, the black screen with more available diffuse photosynthetically active radiation (µmol m^{-2} s^{-1}) provided plants with diameters larger than the aluminized screen.

TABLE 6. Stem diameter (SD), chlorophyll index (CI) and height and stem diameter rate (HSDR) of mangabeira in different protected environments and substrates. Cassilândia 2013-2014.

Substrates	SD (mm)		CI (CCI)		HSDR (cm)	
	Aluminized screen	Black screen	Aluminized screen	Black screen	Aluminized screen	Black screen
S1	2.79 cA	2.83 dA	23.74 bB	36.06 aA	8.57 aA	8.86 aA
S2	2.86 cA	2.94 cA	16.35 bB	29.84 bA	7.82 aA	8.12 bA
S3	3.21 bA	2.90 dA	21.62 bB	34.09 aA	7.20 bB	8.51 aA
S4	3.27 bA	3.12 cA	14.09 bB	27.24 bA	7.34 bB	8.94 aA
S5	3.61 aA	3.58 aA	27.73 aA	24.64 bA	7.41 bA	7.92 bA
S6	3.12 cA	3.39 bA	30.64 aA	28.93 bA	7.86 aA	7.45 bA
S7	3.44 bA	3.39 bA	33.53 aA	38.24 aA	7.39 bA	7.76 bA
S8	3.89 aA	3.59 aA	30.56 aA	28.16 bA	7.95 aA	7.80 bA
S9	3.30 bA	3.30 bA	21.86 bA	24.49 bA	8.30 aB	9.27 aA
S10	3.01 cA	2.49 dB	25.76 aA	22.58 bA	8.02 aA	7.93 bA
S11	3.41 bA	2.99 cB	25.38 aB	35.57 aA	8.10 aB	8.93 aA
S12	3.29 bA	3.20 bA	23.18 bA	30.69 bA	7.67 bB	9.03 aA
S13	3.32 bB	3.88 aA	22.74 bA	22.60 bA	7.77 aA	7.35 bA
CV (%)	10.72		31.03		9.77	

*Uppercase letters in the same rows and lowercase in columns, for each parameter, do not differ from each other by the Scott-Knott test for the substrates and by the F test for cultivation environments, at 5% probability.

For chlorophyll index (CI) in leaves, in the aluminized screen, was observed that substrates with variations of fine vermiculite in the compositions (S1 to S4), compared with the substrates with sand variations (S6 to S8), and medium vermiculite variations (S12 and S13), had higher CI values (Table 6).For plants of the black screen, the S3, S7 and S11 substrates with 30% of manure, 30% of soil and 40% of inert material (sand and vermiculite) propitiated the largest CI values (Table 6), showing the influence of the manure amount present in the substrate for this variable.

In the environments comparison, for the S1 to S4 substrates, as well as the S11 substrate, the higher CI values were observed in the black screen. For other substrates, the environments did not differ (Table 6).

Several factors influence in the photosynthetic rate and the formation of chlorophyll, such as light, water supply, CO_2 concentration and environment temperature. In both analyzed environments the radiations and temperature were similar (Table 4), however the nutrients availability were different in manure percentages that influenced the chlorophyll formation (Table 6).In S7 substrate of A2, the CI was 38.24, the results were below compared to the results obtained by SILVA et al. (2009) and SILVA et al. (2011), who found CI with averages up to 56.25 CCI and 23.54 CCI respectively. The CI obtained from a plant is linked to the photosynthetic efficiency, where the amount of light energy and the type of cultivation conditions are connected, providing a good development to this plant.

The HSDR values in the aluminized screen (A1) show that the substrates with higher percentages of inert and porous material (S3, S4, S5, S7 and S12), and which do not exceed 30% of cattle manure in their composition, presented the best ratios (Table 6).In the black screen, these lower ratios were verified on substrates that differed their compositions, such as S2 (40% of manure and 30% inert and porous material) and S13 (10% of manure, and 60% of inert and porous material) (Table 6).

The HSDR values ranged from 7.20 to 9.27 at 90 DAE (112 DAS), which was similar to what was reported by SILVA et al. (2009) with 7.30 at 160 days after sowing and below of SILVA et al. (2011) that was 4.17, both working with the same species. These results show that when the seedlings were younger had a faster grow when compared to the stem thickening (Table 6).

In the three collections of leaves number (30, 60 and 90 DAE), the S5 and S8 substrates, in both environments, provided a tendency toward a greater number of leaves, allowing better capture of light energy for conducting photosynthesis (Table 4) and adequate development of mangabeira seedlings (Table 7).The seedlings reached, at 90 DAE, 22 leaves, result higher than what was observed by SILVA et al. (2009) at 160 days that reported LN of 18.33 and DIAS et al. (2009a) at 90 DAE found 19 leaves per seedling (Table 7).

In the comparison of environments for each type of substrate, was noted for the S2, S5, S9, S12 and S13 substrates higher LN in the black screen environment (Table 7) in which there was greater availability of diffuse photosynthetically radiation (Table 4).This result shows that not only the formulation of the substrate affects the mangabeira seedlings leaves number, but also the environmental conditions offered.

TABLE 7. Leaves number at 30, 60 and 90 DAE of mangabeira in different protected environments and substrates. Cassilândia-MS, 2013-2014.

Substrates	LN 30 DAE		LN 60 DAE		LN 90 DAE	
	Aluminized screen	Black screen	Aluminized screen	Black screen	Aluminized screen	Black screen
S1	9.89 bA	10.16 aA	16.53 aA	16.76 bA	19.01 bA	18.88 cA
S2	9.68 bA	9.53 bA	15.26 bA	16.09 cA	16.79 bB	19.05 cA
S3	9.54 bA	9.71 bA	16.20 bA	15.83 cA	17.63 bA	18.44 cA
S4	9.29 bA	9.96 bA	15.31 bA	16.41 cA	17.97 bA	19.53 bA
S5	9.90 bA	9.62 bA	16.81 aB	19.26 aA	19.28 bB	22.34 aA
S6	9.92 bA	10.39 aA	15.89 bA	17.04 bA	18.39 bA	19.81 bA
S7	10.04 bA	9.71 bA	16.13 bA	16.86 bA	18.55 bA	19.80 bA
S8	11.13 aA	10.16 aB	18.26 aA	17.85 bA	22.29 aA	21.25 aA
S9	9.98 bA	10.31 aA	12.55 cB	15.67 cA	13.89 cB	17.45 cA
S10	9.86 bA	8.14 cB	15.73 bA	14.56 cA	18.58 bA	16.69 cA
S11	10.35 bA	9.92 bA	16.99 aA	17.21 bA	20.77 aA	19.92 bA
S12	10.05 bA	10.48 aA	13.30 cB	17.50 bA	14.63 cB	18.93 cA
S13	10.25 bA	9.77 bA	13.51 cB	16.83 bA	13.94 cB	17.77 cA
CV (%)	7.12		9.31		10.94	

*Uppercase letters in the same rows and lowercase in columns, for each parameter, do not differ from each other by the Scott-Knott test for the substrates and by the F test for cultivation environments, at 5% probability.

Analyzing the PH in the aluminized screen, it was noted that the S8 substrate in the three collection periods (30, 60 and 90 DAE) had larger plants (Table 8), reaching 30.89 cm at 90 DAE, similar result to what was observed for the leaves number (Table 7).In the black screen at 30 DAE in S3 and S10 substrates, were verified the smallest plants, at 60 DAE the largest seedlings were observed in S5, S8, S9, S12 and S13 substrates and at 90 DAE in S4, S5, S7, S8, S9, S10, S11, S12 and S13 substrates (Table 8).It can be highlighted that the S8 substrate, which contained in its mixture only 20% of cattle manure, was the only one to show higher results in all collections, in both environments, corroborating with SILVA et al. (2009), who reported that the use of 10 and 20% of cattle manure in substrate propitiated the best features for a healthy and good quality of mangabeira (*Hancornia speciosa*) seedling. Besides that, DIAS et al. (2009b) found that the use of manure above 10% on substrate reduced root growth and leaf expansion of mangabeira seedlings and ARTUR et al. (2007), obtained similar results when working with forest species (jatobazeiro), in which the seedling height was lower when increased the dose of manure in the substrate.

Comparing the environments for plant height, was observed larger seedlings in the aluminized screen compared to the black screen for the S8 substrate at 30 DAE and the S8 and S10 substrates at 60 and 90 DAE (Table 8). Larger seedlings in the black screen when compared to the aluminized screen were checked in S12 substrate at 30 DAE, in S9 and S12 substrates at 60 DAE and in S4, S9 and S12substrates at 90 DAE (Table 8).

The height is considered as one of the oldest parameters in the seedlings classification and selection. For DIAS et al. (2009b), the treatments that showed the highest growth rate corresponded to those with cattle manure proportions less than 20%, reflecting the importance of organic matter in the seedlings process formation, which can prove that in mixtures with 50% of manure had the worst results (Table 8).

TABLE 8. Plant height (PH) at 30, 60 and 90 DAE of mangabeira in different protected environments and substrates. Cassilândia 2013-2014.

Substrates	PH 30 DAE		PH 60 DAE		PH 90 DAE	
	Aluminized screen	Black screen	Aluminized screen	Black screen	Aluminized screen	Black screen
S1	9.31 bA	9.71 aA	19.45 dA	20.76 bA	23.83 cA	25.01 bA
S2	8.29 cA	8.78 aA	18.57 dA	18.69 cA	22.38 cA	23.66 bA
S3	8.40 cA	8.20 bA	19.30 dA	17.75 cA	22.96 cA	24.67 bA
S4	7.83 cA	8.88 aA	17.94 dA	19.95 bA	23.84 cB	27.68 aA
S5	9.51 bA	9.32 aA	23.11 bA	23.69 aA	26.73 bA	28.27 aA
S6	9.41 bA	9.07 aA	20.24 cA	19.63 bA	24.39 cA	24.78 bA
S7	8.44 cA	8.82 aA	21.28 cA	20.28 bA	25.32 cA	26.29 aA
S8	12.53 aA	9.65 aB	25.94 aA	22.22 aB	30.89 aA	28.01 aB
S9	9.28 bA	9.77 aA	21.57 cB	24.10 aA	27.21 bB	30.52 aA
S10	8.51 cA	7.36 bA	20.51 cA	14.12 dB	24.00 cA	19.83 cB
S11	9.56 bA	8.85 aA	22.93 bA	20.96 bA	27.59 bA	26.57 aA
S12	8.87 cB	10.30 aA	21.10 cB	23.58 aA	25.21 cB	28.80 aA
S13	9.71 bA	9.30 aA	21.76 cA	22.50 aA	25.79 cA	28.35 aA
CV (%)	12.99		10.38		10.79	

*Uppercase letters in the same rows and lowercase in columns, for each parameter, do not differ from each other by the Scott-Knott test for the substrates and by the F test for cultivation environments, at 5% probability.

Greater shoot dry masses were observed in seedlings in S8 substrate, followed by S5 and S11 substrates inside the aluminized screen and in the S5 substrate, followed by S8 and S13 substrates inside the black screen. For the root system dry mass, higher dry phytomasses were found in the S5 substrate, followed by S8, S9 and S13 substrates in aluminized screen, and S13 substrate, followed by S5 and S8 substrates in black screen (Table 9).The highest total dry phytomasses were found in plants grown in S5 and S8 substrates in the aluminized screen and S13 substrate in the black screen (Table 9).

In the S5, S8 and S13 substrates, where seedlings with higher dry phytomasses were observed (Table 9), the percentage of maximum manure was 20%. Small amounts of manure in substrates showed higher quality seedlings, being in accordance with DIAS et al. (2009b) and SILVA et al. (2009). There were 112 days of experiment and at the 103 were found nutritional deficiency and carried out nutrients application, by foliar via and were observed a fast reaction from the plant to the application. Even using cattle manure in the substrate, depending on the amount of days that the seedling remains in the nursery, there is a need for additional fertilizer.

In the S1, S6 and S10, the substrates percentage of cattle manure was 50% (Table 1) and in these substrates were not observed high quality seedlings as the accumulation of dry phytomasses (Table 9), confirming the results of PAIVA SOBRINHO et al. (2010) who verified low quality seedlings in substrates containing 50% of cattle manure when compared with substrate containing only soil.

TABLE 9. Shoot dry mass (SDM), root system dry mass (RDM) and total dry mass (TDM) of mangabeira in different protected environments and substrates. Cassilândia 2013-2014.

Substrates	SDM (g)		RDM (g)		TDM (g)	
	Aluminized screen	Black screen	Aluminized screen	Black screen	Aluminized screen	Black screen
S1	1.259 cA	1.343 dA	0.394 dA	0.424 eA	1.653 cA	1.767 eA
S2	1.159 cB	1.454 dA	0.381 dA	0.378 eA	1.540 cA	1.832 eA
S3	1.172 cA	1.396 dA	0.476 dA	0.333 eB	1.647 cA	1.729 eA
S4	1.293 cB	1.595 dA	0.417 dA	0.426 eA	1.711 cA	2.021 dA
S5	1.708 bB	2.464 aA	0.945 aA	0.844 bA	2.653 aB	3.308 aA
S6	1.259 cA	1.508 dA	0.424 dA	0.491 dA	1.682 cA	1.999 dA
S7	1.471 cA	1.546 dA	0.598 cA	0.516 dA	2.070 bA	2.062 dA
S8	1.923 aA	1.976 bA	0.730 bA	0.784 bA	2.653 aA	2.761 bA
S9	1.484 cB	1.788 cA	0.796 bA	0.611 cB	2.280 bA	2.399 cA
S10	1.402 cA	1.005 eB	0.386 dA	0.359 eA	1.788 cA	1.365 fB
S11	1.572 bA	1.444 dA	0.595 cA	0.454 eB	2.167 bA	1.898 eA
S12	1.264 cB	1.760 cA	0.570 cA	0.621 cA	1.833 cB	2.380 cA
S13	1.356 cB	2.118 bA	0.719 bB	0.964 aA	2.075 bB	3.082 aA
CV (%)	18.52		18.28		15.36	

*Uppercase letters in the same rows and lowercase in columns, for each parameter, do not differ from each other by the Scott-Knott test for the substrates and by the F test for cultivation environments, at 5% probability

Comparing the cultivation environments for substrates with higher dry phytomasses (S5, S8 and S13), were observed that black screen led to plants with higher dry phytomass than the aluminized screen for the S5 and S13 substrates and the environments did not differ to the S8 substrate (Table 9).In the black screen, there was greater availability of diffuse photosynthetically active radiation (Table 4) which may have favored the phytomass growth in S5 and S13 substrates.

A suitable distribution of phytomass is 2:1 ratio (SRDM), that is, the air phytomass will be the double of the root. In this work the best relations were the S5, S9 and S13 substrate mixtures in the aluminized screen, which have in their formulations 10% of cattle manure, and high percentages of vermiculite and sand (Table 10).

For the variable HSDMR, the best results are S5 and S8 to the aluminized screen and S5, S8 and S13 to the black screen, and the HSDMR ranged from 11.67 to 20.63 cm g^{-1} (Table 10). ROSA et al. (2005) working with the same species found HSDMR values of 6.68, SILVA et al. (2009) of 14.56 and SILVA et al. (2011) of 19 g cm^{-1}.

TABLE 10. Ratio between shoot dry mass and root system dry mass (SRDM), ratio of height and shoot dry mass (HSDMR) and Dickson quality index (DQI) of mangabeira in different protected environments and substrates. Cassilândia 2013-2014.

Substrates	SRDM (g)		HSDMR (g.cm)		DQI (g.cm)	
	Aluminized screen	Black screen	Aluminized screen	Black screen	Aluminized screen	Black screen
S1	3.208 aA	3.169 bA	19.03 aA	18.79 aA	0.1406 dA	0.1476 dA
S2	3.269 aA	3.840 aA	19.95 aA	16.46 aB	0.1399 dA	0.1540 dA
S3	2.493 bB	4.434 aA	19.92 aA	17.90 aA	0.1704 dA	0.1344 dB
S4	3.150 aA	3.866 aA	18.81 aA	17.53 aA	0.1639 dA	0.1608 dA
S5	1.855 cB	3.071 bA	16.20 bA	11.67 bB	0.2877 aA	0.3044 aA
S6	3.018 aA	3.170 bA	19.49 aA	16.97 aA	0.1555 dB	0.1913 cA
S7	2.484 bA	3.145 bA	17.38 bA	17.77 aA	0.2101 cA	0.1896 cA
S8	2.669 bA	2.623 bA	16.19 bA	14.59 bA	0.2513 bA	0.2649 bA
S9	1.862 cB	2.908 bA	18.63 aA	17.64 aA	0.2256 cA	0.1965 cA
S10	3.756 aA	3.070 bA	17.26 bB	20.63 aA	0.1539 dA	0.1234 dA
S11	2.651 bA	3.313 bA	17.68 bA	20.25 aA	0.2019 cA	0.1579 dB
S12	2.235 bA	2.852 bA	20.18 aA	16.46 aB	0.1852 dA	0.2013 cA
S13	1.896 cA	2.249 bA	19.28 aA	13.72 bB	0.2153 cB	0.3226 aA
CV (%)	25.13		17.72		16.90	

*Uppercase letters in the same rows and lowercase in columns, for each parameter, do not differ from each other by the Scott-Knott test for the substrates and by the F test for cultivation environments, at 5% probability

The DQI is an indicator of seedlings quality that involves various morphological variables and is considered a balanced distribution. In the DQI evaluation, the value found for the S5 substrate in the aluminized screen was 2.78, and in the black screen the value of 0.304 in S5 and 0.322 in the S13 at 90 DAE (Table 10).Studying the same species, SILVA et al. (2009) found value of 0.18 at 160 days DAE, and SILVA et al. (2011) obtained 0.20 also at 160 DAE. It can be defined that the best results are substrates that have lower percentages of manure in contrast high values of vermiculite and sand what gave very positive results. Substrates with high percentages of manure, as S1 and S2, were the ones that showed the worst results of the variable, being not recommended for both environments (Table 10).

In S5 substrate, was found the best averages of DQI, HSDMR, SRDM, SD, TDM, providing an adequate development of the seedlings (Table 6, Table 9 and Table 10).For the DQI, the environment did not affect the S5 substrate, however in other substrates it became influential (Table 10).The DQI is a good indicator of the seedlings quality because in its calculation is considered the robustness and the balance of biomass distribution in the seedling, considering the results of several important parameters used to evaluate the quality (COSTA et al., 2012b).

CONCLUSIONS

From the results, it can be concluded that:

- The two environments, the black screen and the aluminized screen are indicated for forming mangabeira seedlings.

- In the aluminized screen environment, is indicated the formation of mangabeira seedlings in S8 substrate (20% M + 30% S + 10% MV + 30% FV + 10% FS).

- In the black screen, is indicated the formation of mangabeira seedlings in S5 substrate (10% M + 30% S + 10% MV + 10% FV + 40% FS) and S13 substrate (10% M + 30% S + 40% MV + 10% FV + 10% FS).

- It is not recommended the formation of mangabeira seedlings in substrate containing 30% or more of cattle manure in mixture with other materials used.

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