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Substrates to produce Jambolan (*Syzygium cumini*) seedlings

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Abstract

Jambolan (*Syzygium cumini* L., also known as jambul, java plum, Portuguese plum, among others) is used as an ornamental, medicinal and edible plant and, given its large and diverse uses, high-quality seedlings are desired for fruit farming. This study sought to evaluate the growth and formation of *Syzygium cumini* seedlings in several substrates. The experiment was conducted in a completely randomized design, with 13 treatments comparing different substrates (S) made with different proportions of bovine manure, subsurface soil, Bioplant®, superfine vermiculite and fine sand. Growth variables of the seedlings, such as height, stem base diameter, mass and biometric ratios were evaluated. Substrates containing 10 to 30% bovine manure and 20 to 40% vermiculite, as in S7 (30%BM+30%SS+10%BP+20%FV+10%FS) and S9 **(**S9=10%BM+30%SS+10%BP+40%FV+10%FS)**,** yielded the best seedlings with adequate values for diameter, mass and Dickson quality index. Substrates with the largest amounts of bovine manure (50%) showed the worst mass distributions. Substrates with high amounts of Bioplant® or fine sand are not recommended for jambolan seedling formation.

Keywords: Dickson quality index, bovine manure, sand, vermiculite, soil.
Abbreviations: BM_bovine manure; SS_subsurface soil; BP_Bioplant®; FV_superfine vermiculite; FS_fine sand; H_Plant height; CD_stem base diameter; HDR_height/stem base diameter ratio; SDM_Shoot dry mass; RDM_root dry mass; TDM_total dry mass; SMR_shoot/root dry mass ratio; RMR_root/total dry mass ratio; DQI_Dickson quality index; RGR_relative growth rate; DAS_days after sowing.

Introduction

Syzygium cumini L., also known as jambul, java plum, Portuguese plum, among others, belongs to the Myrtaceae family and has nutritional properties that prevent diabetes and high antioxidant activity, among other medicinal uses. The *Syzygium cumini* fruit is more often consumed *in nature*, but the tree can be used ornamentally, often in parks, squares, and gardens (Mazzanti et al., 2003). This fruit plant native to India and of great rusticity adapted itself to the Brazilian edaphoclimatic conditions, mainly in Northeast Brazil, with trees reaching up to 10 m in height and branched canopy with several fruits (Souza and Lorenzi 2005).

The fruits are berry-like, small and ovoid, and the fruiting period takes place from January to May in Brazil. The fruit goes through three stages of coloration during its cycle, changing from green to pink to blood red to black as it matures, with fleshy pulp and little astringent taste (Cavalcanti, 2010).

Syzygium cumini propagation usually takes place by seeds, which can cause various problems in descendant plants and failures in seedling formation. Another factor that hampers seedling formation is the difficulty in separating the embryos at thinning because this is a polyembryonic species (Cavalcanti, 2010).

Substrates strongly influence the quality of the seedlings, as they provide them with nutrients and water for the development and growth and act as support and fixation for the root. Substrates should be free of soil pathogens and invasive plant seeds and should be available at the seedling production site (Oliveira and Jardim, 2013). The mixture of sand and bovine manure gave greater root volume to the *Syzygium cumini* seedlings, while the combination of manure, sand, and soil favored the seedlings' growth as a whole (Cavalcanti, 2011). For other fruits has been reported the use of manure associated with vermiculite as favoring the formation of high-quality seedlings. For example, Baru (*Dipteryx alata* Vog) (Costa et al., 2015), passion fruit (*Passiflora edulis*) (Lima et al., 2016), jatobá (*Hymenaea courbaril*) (Sanches et al., 2017) and mangaba (*Hancornia speciosa*) (Arrua et al., 2016).

For use a material as a substrate, some things must be considered like the species that will be cultivated and the time required for its growth which, added to the type of container, can limit the growth of the root system. Additionally, many studies in the literature emphasize that substrates must provide adequate physical conditions for the development of seedlings, such as aeration, water

retention capacity, structure, good porosity and other characteristics that may or may not favor seed germination.
Given the need to increase knowledge about the cultivation of fruit species, this study sought to evaluate the growth and formation of seedlings of *Syzygium cumini L.* cultivated in different substrates, in an attempt to obtain high-quality seedlings for commercial farming.

Results and Discussion

Plant growth and development

At 30 DAS, the plants cultivated in substrates S1, S2, S8 and S12 differed from the plants grown in S5, showing higher average heights, but they did not differ from the remainder of treatments (Table 4). At 60 DAS, the seedlings in substrates S1 and S7 were larger than those grown in substrates S3, S4, S5, S11, and S13. At 90 DAS, the seedlings of S1, S2, and S6 were larger than those cultivated in substrates S3, S4, S5, S11, S12, and S13.
Concerning the height parameter, it was observed that at 90 DAS the substrates containing 40 to 50% bovine manure showed higher growth in height, but still with similar results to the substrates with fewer amounts of manure, 10 to 30%, and larger amounts of vermiculite, 20 to 40%. It evinced that the physical and chemical properties of such substrates were adequate to the *Syzygium cumini* seedlings (Table 4).
Results in the literature on *Syzygium cumini* seedlings show that larger seedlings were obtained in substrates with 33.33% bovine manure (Cavalcanti, 2010). At 60 DAS, the seedlings reached a height of 20.84 cm in S1, and 18.52 cm in S2, and 18.28 cm in S6, superior results to those achieved by Cavalcanti (2010), who obtained seedlings of 16.1 cm at 52 DAS. The use of more than 30% bovine manure in substrates was not recommended by Costa et al. (2015) for Baru (*Dipteryx alata* Vog), Dias et al. (2009a), by Silva et al. (2009) for mangaba (*Hancornia speciosa* Gomez), by Dias et al. (2009) for coffee (*Coffea arabica* L.) and by Cavalcanti (2010) for *Syzygium jambolanum* Lam.. The results obtained for seedling height in the present study showed similar values for the use of 10 to 30% bovine manure with the addition of 20 to 40% vermiculite, in comparison to substrates S1, S2 and S6 (90 DAS) using 40 to 50% manure.
At 90 DAS, it was verified in substrates S1 and S2 the seedlings presented a larger stem base diameter (4.39 mm and 4.40 mm, respectively) when compared to those cultivated in substrates S3, S4, S5, S11, and S13, which are higher values than those achieved by Cavalcanti (2010), who reported 3.2 mm diameters for *Syzygium cumini* seedlings at 52 DAS.
Height/stem base diameter ratio allow evaluating the level of etiolation and the leaning potential of the seedlings when submitted to the field conditions. In the experiment, substrate S13 presented a low height/stem base diameter ratio, but not different from that of substrates S5 and S12 (Table 4). Carneiro (1995) examined in Eucalyptus (*Eucalyptus* spp) seedlings that a height/stem base diameter ratio ranging from 5.4 to 8.1 is within the range classified as adequate, so substrate S6 in the present experiment did not fit this adequate range. It is important to consider, however, that for some species this is not a suitable parameter (Table 4).

Substrates containing 20 and 40% Bioplant® (S11 and S13), as well as substrates containing 20, 30 and 40% fine sand (S3, S4, and S5) did not yield adequate diameters or heights for *Syzygium cumini* seedlings. It is because Bioplant® did not provide the seedling with satisfactory nutritional (nutrient availability) and physical conditions for its growth when compared to bovine manure. The same result was observed for the use of vermiculite in detriment of sand, showing adequate physical conditions for the substrate, such as high water retention, high porosity, low density and high CEC. These results corroborate with those obtained by Borges et al. (2016) who stated that Bioplant®, even supplemented with other compounds such as vermiculite and coconut powder at proportions of 20% to 40%, did not increase the height of *Eugenia calycina* plants.
Shoot dry mass (SDM), root dry mass (RDM), and total dry mass (TDM) of the seedlings grown in substrate S9 were higher than those cultivated in substrates S3, S4, S5, S11, and S13, however not different from the remaining substrates (Table 5).
Substrate S9 was composed of 40% superfine vermiculite, and it is known that this component improves the physical and chemical conditions of the substrate because it releases magnesium ions to the solution thereof and absorbs phosphorus and nitrogen in the ammoniacal form. Vermiculite together with organic manure matter provided adequate conditions for the accumulation of dry matter, as can be seen in substrates S1, S7, S8, S10, and S12. Possibly, this mixture gave the substrate better physical and chemical conditions, regulating the water and oxygen supply for the roots. It also provided chemical elements for nutrition, promoting the satisfactory development of the *Syzygium cumini* seedlings, with larger dry masses. The same was observed for other fruits, such as Baru (*Dipteryx alata* Vog) (Costa et al., 2015), passion fruit (*Passiflora edulis*) (Lima et al., 2016), jatobá (*Hymenaea courbaril*) (Sanches et al., 2017) and mangaba (*Hancornia speciosa*) (Arrua et al., 2016).
It was observed that the substrates containing 20 and 40% Bioplant® (S11 and S13), as well as those containing 20, 30 and 40% fine sand (S3, S4, and S5), presented the lowest dry masses in *Syzygium cumini* plants (Table 5). Fine sand particles are smaller than superfine and medium vermiculite particles, so the substrates with high amounts of such materials presented lower microporosity, as mentioned by Smiderle et al. (2001) for a substrate with 33.33% of sand, showing lower total porous space. A similar situation may have occurred to the substrates with 20, 30 and 40% fine sand (S3, S4, and S5, respectively), which did not provide adequate physical conditions for mass accumulation in the *Syzygium cumini* seedlings.
The negative effect of Bioplant® mixed with fine sand in the substrates for *Syzygium cumini* seedlings may be related to the physical and chemical characteristics of these components, which do not allow adequate growth of shoot, root and total masses. Alves et al. (2012) reported that, for seedlings of *Crateva tapia* L. submitted to a temperature of 20º to 30ºC, the use of Bioplant® did not promote adequate root development. Dutra et al. (2012) reported that, in the production of Copaíba (*Copaifera langsdorffii* Desf.) seedlings, Bioplant® presented lower results for shoot dry mass, total dry mass, and shoot/total dry mass ratio, compared to substrates composed of vermiculite and carbonized rice hulls. The same authors reported that the

Table 1. Substrates made with mixtures in different proportions of bovine manure (BM), subsurface soil (SS), Bioplant® (BP), superfine vermiculite (FV) and fine sand (FS).

Substrates	Bovine Manure (BM%)	Subsurface Soil (SS%)	Bioplant (BP%)	Superfine Vermiculite (FV%)	Fine Sand (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	0	10

BM=bovine manure; SS=subsurface soil; BP=Bioplant®; FV= superfine vermiculite; FS=fine sand.

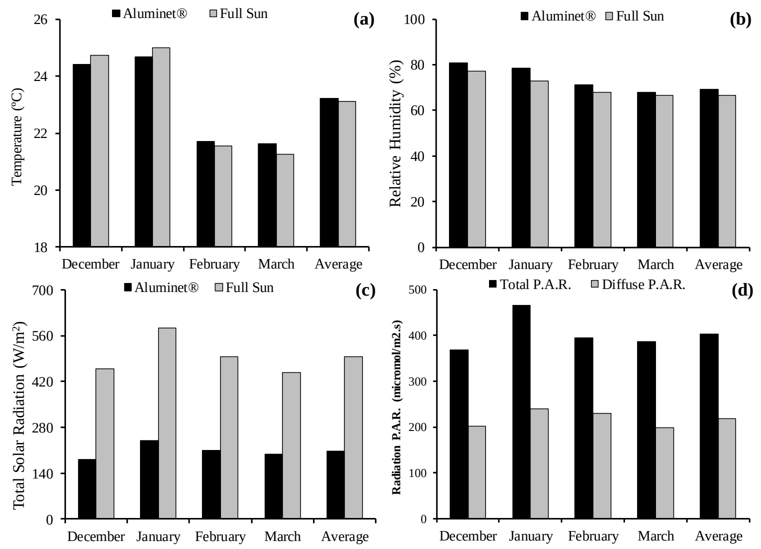

Fig 1. Temperature (a), relative humidity (b), total solar radiation (c) and total and diffuse photosynthetically active radiation (d) recorded for the protected and the full sun environments during the experimental period.

Table 2. Bovine manure analysis, Cassilândia- MS, Brazil, 2014-2015.

N	P_2O_5	K_2O	Ca	Mg	S	M-65ºC	C
		-------------------	------------------- % natural	-------------------	-------------------		
0.9	0.3	0.1	0.3	0.1	0.2	2.0	11.0
Na	Cu	Fe	Mn	Zn	C/N	pH	OM
	----------	----------$mg\ kg^{-1}$ natural	----------			$CaCl_2$	% natural
624	18	12103	204	53	12/1	5.3	20.0

M = moisture; OM = organic matter; C/N = carbon and nitrogen ratio.

Table 3. Subsurface soil analysis, Cassilândia-MS, Brazil, 2014-2015.

P_{resine}	K	Ca	Mg	SB	CTC	V%
$mg\ dm^{-3}$		_ _ _ _ _ _ _ _	_ _ _ mmolc dm^{-3} _ _ _	_ _ _ _ _ _ _ _		
9	1.0	8	3	12	67	18
pH	OM	B	Cu	Fe	Mn	Zn
Water	$g\ dm^{-3}$		_ _ _ _ _ _ _	_ _ _ mg dm^{-3} _ _ _	_ _ _ _	
4.4	5	0.19	0.4	30	8.8	0.3

OM = organic matter.

Table 4. Plant height (H, cm) at 30 (H1), 60 (H2) and 90 (H3) DAS, stem base diameter (CD, mm) at 90 DAS and height/stem base diameter ratio (HDR) of *Syzygium cumini* seedlings. Cassilândia, MS, Brazil, 2014-2015.

Substrates	H1 (30 DAS)	H2 (60 DAS)	H3 (90 DAS)	CD (90 DAS)	HDR (90 DAS)
S1	8.04 a	20.84 a	32.81 a	4.39 a	7.48 abc
S2	8.52 a	18.91 ab	32.97 a	4.40 a	7.46 abc
S3	6.75 ab	13.26 cde	24.89 bcd	3.49 bcde	7.10 bc
S4	6.38 ab	10.86 de	22.21 cde	3.27 bcde	6.78 abc
S5	5.58 b	8.86 e	17.28 e	2.63 e	6.60 cd
S6	7.38 ab	18.28 abc	33.63 a	3.97 abc	8.44 a
S7	7.61 ab	19.45 a	31.90 ab	4.14 ab	7.68 abc
S8	8.03 a	18.34 ab	29.82 ab	3.78 abcd	7.91 ab
S9	7.55 ab	18.84 ab	28.60 abc	3.98 ab	7.15 bc
S10	7.72 ab	18.58 ab	31.88 ab	4.07 ab	7.80 abc
S11	6.98 ab	12.42 de	21.52 cde	3.00 de	7.20 bc
S12	8.35 a	18.87 ab	24.76 bcde	3.55 abcd	6.99 bcd
S13	7.64 ab	14.14 bcd	18.00 de	3.10 cde	5.84 d
CV (%)	13.50	14.19	12.76	10.90	7.57

Equal letters in the columns do not differ at 5% probability by the Tukey's test; CV = coefficient of variation; BM=bovine manure; SS=subsurface soil; BP=Bioplant®; FV= superfine vermiculite; FS=fine sand.

Table 5. Shoot dry mass (SDM), root dry mass (RDM), total dry mass (TDM), shoot/root dry mass ratio (SMR) and root/total dry mass ratio (RMR) of *Syzygium cumini* seedlings, Cassilândia, MS, Brazil, 2014-2015.

SUBSTRATES	SDM (g)	RDM (g)	TDM (g)	SMR	RMR
S1	4.93 abc	3.1 bcde	8.03 abcd	1.58 a	0.38 c
S2	4.88 abc	3.47 abcd	8.36 abc	1.40 ab	0.41 abc
S3	3.76 bcde	2.68 cde	6.45 bcde	1.40 ab	0.41 abc
S4	3.35 de	2.59 de	5.95 de	1.29 ab	0.43 abc
S5	2.89 e	2.35 e	5.24 e	1.23 ab	0.44 abc
S6	4.87 abc	3.07 bcde	7.95 abcd	1.59 a	0.38 c
S7	4.76 abcd	3.9 ab	8.67 ab	1.23 ab	0.44 abc
S8	5.09 ab	3.43 abcd	8.53 ab	1.49 ab	0.40 bc
S9	5.62 a	4.13 a	9.75 a	1.35 ab	0.42 abc
S10	5.19 ab	3.45 abcd	8.64 ab	1.55 a	0.40 bc
S11	3.54 cde	2.71 cde	6.26 cde	1.31 ab	0.43 abc
S12	4.39 abcd	3.64 abc	8.03 abcd	1.19 ab	0.45 ab
S13	2.87 e	2.62 de	5.49 e	1.09 b	0.47 a
C.V. (%)	15.79	14.55	13.71	13.54	7.00

Equal letters in the columns do not differ at 5% probability by the Tukey's test; CV = coefficient of variation; BM=bovine manure; SS=subsurface soil; BP=Bioplant®; FV= superfine vermiculite; FS=fine sand.

Table 6. Dickson quality index (DQI), relative growth rate (RGR1 and RGR2) and absolute growth rate (AGR1 and AGR2), Cassilândia, MS, Brazil, 2014-2015.

SUBSTRATES	DQI	RGR1 (30-60 DAS)	RGR2 (60-90 DAS)	AGR1 (30-60 DAS)	AGR2 (60-90 DAS)
S1	0.88 abc	0.032 a	0.015 cde	0.42 a	0.39 abc
S2	0.94 abc	0.026 abc	0.018 abcd	0.34 ab	0.46 ab
S3	0.75 bc	0.022 abcd	0.020 abc	0.21 bc	0.38 abc
S4	0.74 bc	0.018 cd	0.024 a	0.14 c	0.37 abc
S5	0.67 c	0.016 d	0.022 ab	0.10 c	0.28 cde
S6	0.79 bc	0.030 ab	0.020 abc	0.36 a	0.51 a
S7	0.97 ab	0.031 a	0.016 bcd	0.39 a	0.41 abc
S8	0.90 abc	0.027 abc	0.016 bcd	0.34 ab	0.38 abc
S9	1.14 a	0.031 a	0.014 def	0.37 a	0.32 bcd
S10	0.92 abc	0.029 ab	0.018 abcd	0.36 a	0.44 abc
S11	0.73 bc	0.018 cd	0.018 abcd	0.18 c	0.30 cd
S12	0.98 ab	0.027 abc	0.009 ef	0.35 ab	0.19 de
S13	0.79 bc	0.020 bcd	0.008 f	0.21 bc	0.12 e
CV (%)	14.63	18.34	17.58	21.32	21.12

Equal letters in the columns do not differ at 5% probability by the Tukey's test; CV = coefficient of variation; BM=bovine manure; SS=subsurface soil; BP=Bioplant®; FV= superfine vermiculite; FS=fine sand.

use of Bioplant® as a substrate material in the production of forest seedlings presented negative results, similar to those achieved in this study.

All the substrates evaluated in the present study showed adequate shoot/root dry mass ratio (SMR), ranging from 1.09 to 1.59. According to Gomes and Paiva (2004), the mass ratio is one of the main parameters to evaluate the survival and initial growth of seedlings in the field, and seedling survival relates to the root amount and distribution regardless of plant height. In the experiment, the satisfactory distribution between shoot and root dry masses allowed the *Syzygium cumini* seedlings to adapt to the region of Cassilândia, as well as the physical and chemical characteristics of the tested substrates, which possibly allowed proper aeration and nutrition.

Concerning the RMR, it was verified the worst mass distribution in the plants cultivated in substrates with 50% bovine manure, in comparison to substrates with 40% Bioplant®. Consequently, in the literature, many authors do not recommend the use of bovine manure above 30% in substrates (Dias et al., 2009a; Silva et al., 2009; Dias et al., 2009b; Cavalcanti, 2010; Costa et al., 2015). However, other authors have reported high-quality seedlings using more than 30% bovine manure (Costa et al., 2012).

Morphological indices

According to Gomes and Paiva (2004), the minimum value to determine the Dickson quality index is 0.20, and the higher the DQI, the better-quality standard of the seedlings. Thus, all treatments in this study are of the ideal proportions. However, the highest values found for shoot dry mass (SDM), root dry mass (RDM) and total dry mass (TDM) reflect the highest Dickson quality index (DQI), which was 1.14 for substrate S9 (Table 6), whose SDM, RDM, and TDM were 5.62, 4.13 and 9.13 g per seedling, respectively. These are adequate data for obtaining high-quality seedlings, which are necessary for the survival of these seedlings and successful field planting.

Plant growth analysis is essential because it reports changes in plant production as a function of time. According to Barbieri Júnior et al. (2007), the relative growth rate of a plant, or any organ of the plant, reflect the organic matter increase at a given time, dependent on the living material.

In this sense, the seedlings cultivated in substrates S1, S7 and S9 reached 0.03 cm day^{-1} relative growth rate in height at 30 to 60 DAS, which was higher than that observed in substrates S4, S5, S11, and S13. From 60 to 90 DAS, substrate S4 showed an increase of 0.02 cm day^{-1}, which is higher than substrates S1, S7, S8, S9, S12 and S13 (Table 6). From 60 to 90 DAS, it was verified that substrate S13 had lower relative growth rates in comparison to S1, S2, S3, S4, S5, S6, S6, S7, S8, S10, and S11.

Seedlings in substrates S1, S6, S7, S9 and S10 from 30 to 60 DAS showed growth rates between 0.36 and 0.42 cm, which were higher than those in substrates S3, S4, S5, S11, and S13, whose values ranged between 0.10 and 0.21 cm day^{-1}. From 60 to 90 DAS, the highest growth was observed in substrate S6 (0.51 cm dia-1), comparing to substrates S5, S9, S11, S12 and S13 which presented values between 0.12 and 0.30 cm day^{-1} (Table 6). It was observed that the *Syzygium cumini* seedlings in substrates S7 and S9, which contained 10 to 30% bovine manure and 20 to 40% vermiculite, were among the highest relative and absolute growth rates in the period from 30 to 60 DAS. Also, these substrates are among those with the highest DQI, total shoot dry mass, plant height and stem base diameter. Finally, it can be said that it is crucial to producing high-quality seedlings before final planting, and with proper management, this practice can be achieved easily and quickly.

Materials and Methods

the *Plant material and site characterization*

Seeds of *Syzygium cumini* L. (Jambolan) were collected from the orchard trees established in savannah areas located at the Mato Grosso do Sul State University (UEMS), in the municipality of Cassilândia, MS, Brazil (19º07'21'' S, 51º43'15'' W, and altitude of 516 m).

The regional climate according to the Köppen classification is Aw, characterized as the tropical climate with hot summers and a tendency towards high rainfall levels, and dry winters, with a dry season between May and September. The 30-year mean annual temperature is 24.1 °C with a July minimum of 16.4 °C and a January maximum of 28.6 °C, and mean annual rainfall of 1,520 mm.

Description of environments

The experiment was conducted from December 2014 to March 2015 at the State University of Mato Grosso do Sul, University Unit of Cassilândia, MS, Brazil a

The protected environment used for the development of the experiment was a plant nursery of galvanized steel structure 8.0 m wide x 18.0 m in length and 4.0 m in height up to the gutter, covered with Aluminet® thermo-reflective aluminized 50%-shade cloth. Installed at 3,3 m from the ground, and black 50%-shade cloth is covering its sidewalls and front.

Inside the protected environment were monitored, air temperature (°C), relative humidity (%), total solar radiation (W m^{-2}), total and diffuse photosynthetically active radiation (µmol m^{-2} s^{-1}). Additionally, micrometeorological data were measured by a specific sensor coupled to the GP2 Data Logger from Delta T Devices, installed in the environment geometric center. The system was programmed to perform readings at 10-second intervals, with averages every minute. Daily it was calculated the average radiation with data monitored from 7:00 a.m. to 6:00 p.m. As for the full sun environment were collected, air temperature, relative humidity and total solar radiation data from the Cassilândia Automatic Weather Station A742-INMET-SONABRA (Figure 1). Irrigation was performed manually with a watering can according to the needs of the seedlings.

Experimental design and trial management

The seeds were collected from plants in the municipality of Cassilândia, State of Mato Grosso do Sul, Brazil, and they were sowed in 1.8-liter black polyethylene bags (15.0 x 25.0 cm). The bags were filled with several proportions of substrates containing bovine manure (BM), subsurface soil (SS), Bioplant® (BP), superfine vermiculite (FV) and fine sand (FS) (Table 1).

The experimental design was completely randomized, comprising 13 treatments with different combinations of substrates with five replicates of five seedlings per plot (Table 1).

The bovine manure was purchased from a local slaughterhouse. It was composed of barn manure and rumen material composted for 30 days, then homogenized and dried. The subsurface soil was collected from a 10-30 cm deep layer at the University Unit of Cassilândia, MS, Brazil, and then it was chemically and physically characterized and sieved (Table 2 and 3).

The Bioplant® substrate was commercially available and, according to the manufacturer, it contains coconut fiber, pine bark, manure, sawdust, vermiculite, rice hull, ash, agricultural gypsum, calcium carbonate, magnesium, magnesium thermophosphate and additives (fertilizers).

Vermiculite is an industrialized material, obtained by the expansion process of mica (rock), submitted to temperatures of 800º to 900ºC. It is considered an almost inert material of variable and very light granulometry, composed of silica tetrahedral sheets and iron (Fe) and magnesium (Mg) octahedral sheets, requiring balanced nutrition by constant fertilization. For substrate purposes, it has right aeration conditions, high cation exchange capacity (CEC) and water retention, and is a material free of pathogens and widely used in seedling production.

Two seeds were planted per bag, at a depth of 1 to 3 cm, and after was performed germination, thinning, leaving only one seed per container – the best-developed seed – taking due care to the fact that they are polyembryonic seeds. Sowing took place on December 11, 2014.

Evaluations carried out

At 30, 60 and 90 days after sowing (DAS), were measured the seedling heights (H) from stem base diameter to shoot tip, using a millimeter ruler, with results expressed in centimeters (cm). At 90 DAS were evaluated, stem base diameter (CD) was measured using a digital caliper, with results expressed in millimeters (mm). Subsequently, shoot dry mass (SDM), root dry mass (RDM) and total dry mass (TDM). The biological material was oven dried in a forced air circulation at a temperature of 65ºC until reaching a constant mass to obtain the masses, which was measured using an analytical balance with data expressed in grams. Also, it was evaluated the height/stem base diameter ratio (HDR), shoot/root dry mass ratio (SMR), root/total dry mass ratio (RMR) and Dickson quality index (DQI). It was calculated the absolute growth rate (AGR) and the relative growth rate (RGR).

Statistical nalysis

The data were submitted to analysis of variance by the F-test and, when significant, the averages were compared at 5% probability by the Tukey's test.

Conclusion

Substrates S7 and S9 containing 10 to 30% bovine manure and vermiculite 20 to 40% yielded the best *Syzygium cumini* seedlings, with adequate stem base diameter, mass ratios, and Dickson quality indexes.

Substrates S1, S6, and S10, with the largest amounts of bovine manure (50%), showed the worst distributions of dry masses (SMR and RMR).

Substrates with high amounts of Bioplant® (S11, S12, S13) or fine sand (S3, S4, S5) are not recommended for the formation of *Syzygium cumini* seedlings.

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