Use of **alternative organic compounds** in the initial growth and quality of *Anadenanthera colubrina* (Vell. Brenan) seedlings

Uso de compostos orgânicos alternativos no crescimento inicial e qualidade de mudas *Anadenanthera colubrina* (Vell. Brenan)

Edson de Oliveira Santos[1], Adriana Miranda de Santana Arauco[1], Bruno de Oliveira Dias[2], Emanuel França Araújo[3]*, Cácio Luiz Boechat[1] and Dayara Lins Porto[1]

1 Universidade Federal do Piauí. Bom Jesus, Piauí, Brasil.

2 Universidade Federal da Paraíba. Areia, Paraíba, Brasil.

3 Universidade Federal do Espirito Santo. Jerônimo Monteiro, Espírito Santo, Brasil.

* Corresponding author. emanuelfa.bj@hotmail.com

Abstract

The use of renewable materials as a source of nutrients, besides being a solution of interest for waste disposal, may also be an effective way to reduce the high costs of inputs needed for the production of forestry seedlings. The purpose of this study was to evaluate the growth of *Anadenanthera colubrina (Vell. Brenan)* (angico branco) cultivated in organic substrates. A randomized block design was adopted and the treatments were distributed in a 3 × 5 factorial scheme, with three organic residues: decomposed burity (moriche palm) stem, carnaúba straw and organic compost mixed with the soil in four percentages: 20%, 40%, 60% and 80% of the composition of substrate and a control treatment with soil only, without incorporating the organic residue, with six repetitions. Ninety days after emergence, the seedlings were collected to determine the growth parameters: stem diameter (SD), height (H), of the following indexes: H/D, leaf number (LN), total chlorophyll (T), leaf area (LA), dry mass of the aerial part (DMAP), dry mass of roots (DMR), total dry mass (TDM) H/DMAP: DMAP/DMR, and Dickson Quality Index (DQI). The treatments that contained 60% and 80% of organic compost presented the best responses. It is concluded that the production of angico branco seedlings cultivated with substrate with the addition of 80:20 (organic compost: soil) presented the best results and was technically feasible according to the characteristics and indexes analyzed.

Keywords: angico branco, composting, forestry species, nutrients.

Resumo

A utilização de materiais renováveis como fonte de nutrientes, além de ser uma interessante solução para destinação dos resíduos, pode também ser uma saída efetiva para a redução dos altos custos de insumos necessários para produção de mudas florestais. Este trabalho objetivou avaliar o crescimento de *Anadenanthera colubrina* (Vell. Brenan) (angico branco) cultivado em substratos orgânicos. Foi adotado delineamento em blocos casualizados e os tratamentos distribuídos em esquema fatorial 3 × 5, sendo três resíduos orgânicos: caule decomposto de buriti, bagana de carnaúba e composto orgânico misturados ao solo em quatro percentuais, 20% ,40%, 60% e 80% da composição do substrato e um tratamento testemunha apenas com solo sem incorporação de resíduo orgânico, com seis repetições. Aos noventa dias após a emergência, as mudas foram coletadas para determinação dos parâmetros de crescimento: diâmetro do coleto (DC), altura (H), dos índices: H/D, número de folhas (NF), clorofila total (CT), área foliar (AF), massa seca da parte aérea (MSPA), massa seca das raízes (MSR) e massa seca total (MST), H/MSPA; MSPA/MSR e de qualidade de Dickson (IQD). Os tratamentos que continham 60% e 80% de composto orgânico apresentaram as melhores respostas. Conclui-se que a produção de mudas de angico branco cultivadas com substratos acrescidos de 80:20 (composto orgânico: solo) apresentam os melhores resultados e tecnicamente viável de acordo com as características e os índices analisados.

Palavras-chave: angico branco, compostagem, espécie florestal, nutrientes.

Introduction

The production of forestry seedlings in nurseries, for the recovery of degraded areas, reforestation and environmental or economic services is very important, because of the intense devastation of native forests. This said, it is necessary to deal with an obstacle, namely, the scarcity of knowledge regarding the silvicultural characteristics, growth pattern and nutritional requirements of the native species of Brazilian flora, as well as appropriate reproduction techniques (Nascimento, Leles, Oliveira-Neto, Moreira & Alonsol, 2012; Delarmelina, Caldeira, Faria, Gonçalves & Rocha, 2014; Da Ros *et al*., 2015).

Angico branco (*Anadenanthera colubrina* (Vell.) Brenan) is an arboreal species belonging to the Fabaceae – Mimosoideae family, that can grow up to 30 meters high with a common distribution throughout the Northeast region (Carvalho, 2013). Although it is a known species, there is scarce information in the literature regarding seedling production.

Angico is a species recommended for the recovery of degraded areas and replacement of gallery forests in flooded terrains; it is also used to plant trees on roadsides, parks and streets (Gross, Cordeiro & Caetano, 2002). Information about the nutrients found in the soil and the nutritional requirements of the plants are important to define strategies to maintain forest sustainability (Vargas & Marques, 2017).

The use of renewable materials as a source of nutrients, besides being a useful solution for residue disposal, can also be effective to reduce the high costs of inputs needed to produce forestry seedlings (Santos, Bidler, Greyce, Layara & Cordeiro, 2013). When organic residues are well managed they can be used as a major source of organic matter and nutrients to formulate an appropriate substrate, since they stimulate the development of beneficial microorganisms, increase the capacity to retain water and nutrients, improve the aeration and aggregation of the substrate to the plant roots and increase the availability of nutrients to the seedling. Further, according to Kratka & Correia (2015), since forestry activity does not involve the production of foods for human consumption, is a promising alternative for using these materials without health risks.

According to Sousa *et al*. (2015) understanding different cultivation methods used to produce tree seedlings directly affects the morpho-physiological characteristics, and there are several materials that can be used to compose the substrate. Among the different materials used are: urban waste compost; biosolids; burnt rice husks; worm humus; tanned bovine manure; and other materials. Due to the existence of several types of residues, it is necessary to evaluate different combinations of these materials in the composition of ideal substrates for each species (Toledo *et al.*, 2015).

Objectives

Assuming that the larger proportions of organic residues in the composition of the substrate may intensify the growth of forestry seedlings, the purpose of the study was to evaluate the growth of angico branco seedlings produced with different proportions of organic residues.

Material and methods

The experiment was conducted in a greenhouse, environment with 75% screen luminosity in the municipality of Bom Jesus – PI, Brazil (09º 04’ 28” S, 44º 21’ 31” W, mean altitude 277 m). The climate in the region is hot and semi-humid type Aw, according to the Köppen classification (Fig. 1).

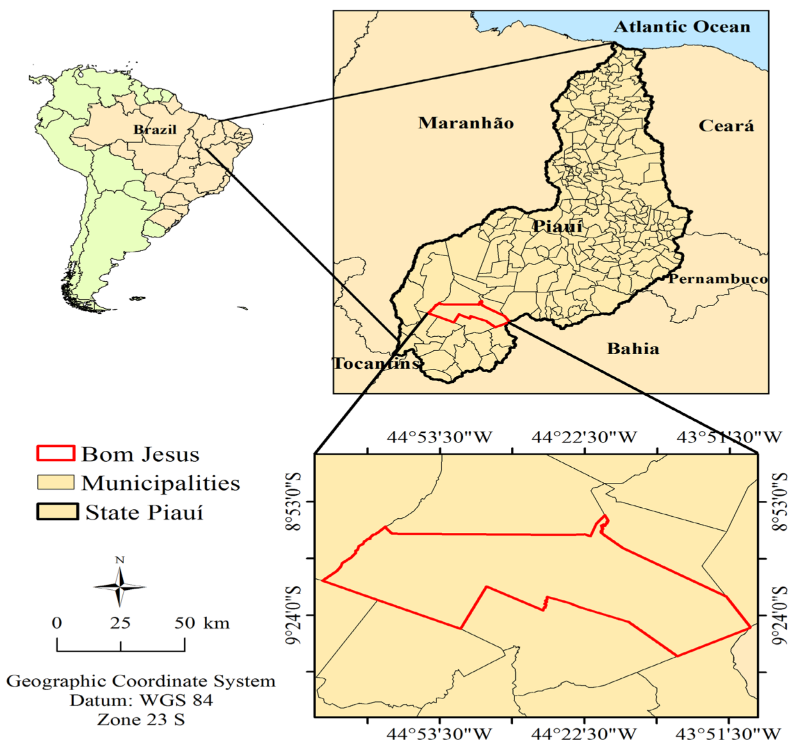

Figure 1. Rainfall and temperature at the Experimental Station of the Federal University of Piauí (UFPI) during the experiment period in a chapel type environment with a 75% luminosity screen in Bom Jesus, PI.

The treatments were disposed in a randomized block design, distributed in a 3 × 5 factorial scheme, with three organic substrates, decomposed burity stem (DBS), carnaúba straw (CS) and organic compost (OC) mixed with the soil in four percentages, 20%; 40%; 60% and 80% of the substrate composition, and a control treatment with soil only, without incorporating organic residues, with six repetitions.

The DBS originates from the natural decomposition of the stem of the burity palm tree *(Mauritia Flexuosa)* and was collected in the municipality of Bom Jesus – PI. The CS (*Copernicia prunifera*) is the straw that results from extraction of wax from the leaf of this species and was collected in the municipality of Batalha - PI and OC was obtained from the composting of remnants of tree pruning and bovine manure. The physical-chemical characterization of the residues was performed according to the methodology described by Silva Júnior, Beckmann-Cavalcante, Silva-Brito, Avelino & Cavalcante (2014) and is shown in table 1.

Table 1. Physical-chemical analysis of the organic materials used in the composition of substrates for the evaluation of angico branco growth.

Organic	N	P	K	Ca	Mg	S	B	Cu	Mn	Zn	Fe	HD	DD	WRC	AS	PV
substrate	——— g kg^{-1} ———						——— mg kg^{-1} ———					kg m^{-3}		—— % ——		
CS	24.8	1.0	2.6	4.5	1.5	2.8	56.7	9.6	142	30.5	17.4	582	219	41	48	89
OC	18.4	6.4	14.6	18.7	5.6	4.9	1.2	0.3	1.7	0.9	10.3	729	527	23	51	74
BS	12.4	2.4	8.1	10.7	2.9	2.1	25.6	5.8	770	411.4	5.9	625	124	57	35	93

CS – carnaúba straw; OC – organic compost; BS – decomposed burity stem; HD – humid density; DD dry density; WRC – Water retention capacity; AS – Aeration space; PV – pore volume.

The soil used in the experiment was described and classified as Latossolo Amarelo distrófico típico according to the Brazilian soil classification system (SIBCS., 2013) with a sandy-loam texture. The soil sample was collected in the 0 cm - 20 cm layer, air dried, sieved with a 2.0 mm mesh sieve, homogenized and then the chemical analysis was performed according to the methodology described by Embrapa (2011). The chemical characteristics of the soil used in the experiment are shown in table 2.

Table 2. Chemical attributes of the soil used as substrate component.

pH	P	K	$Ca^{+2} + Mg^{+2}$	Al^{3+}	H + Al	SB	t	T	m	V	SOM
$CaCl_2$	mg dm^{-3}			cmol$_c$ dm^{-3}					%		g dm^{-3}
3.9	5.3	20.0	0.5	1.8	3.2	1.0	2.4	3.8	76.6	14.6	7.0

SB – sum of bases; t – capacity of effective cation exchange; T – cation exchange capacity at pH 7.0; m – aluminum saturation; V – base saturation; SOM – soil organic matter.

The proportions of each residue were mixed, and the soil samples homogenized and placed in plastic containers with a volume of 1.5 L, totalizing 90 experimental units. The seeds for seedling production were collected from the mother trees without specific management of fertilization, pruning, irrigation and phytosanitary control in the municipality of Bom Jesus. After harvesting, the fruits were taken to the Bioscience Lab for selection, uniformization and manual extraction of the pulp and seeds, which were stored in a refrigerated environment. Three seeds were sown in each experimental unit and after complete emergence, the plantlets were thinned out leaving a more vigorous appearance per experimental unit.

Ninety days after emergence, the seedlings were collected, the aerial and root part were separated, and the morphological and seedling quality parameters were evaluated: stem diameter (SD), plant height (H), height/diameter ratio (H/SD), leaf number (LN), total chlorophyll (TC), leaf area (LA), dry mass of aerial portion (DMAP), dry mass of roots (DMR), total dry mass (TDM), ratio of dry mass of aerial portion/dry mass of roots (DMAP/DMR), ratio of height /dry mass of aerial part (H/DMAP), and Dickson´s quality index (DQI). In order to evaluate the weight of biomass the plants were measured and then taken to the oven with forced air circulation at 65 °C for 72 hours and weighed again.

When several characteristics are evaluated simultaneously, the relative genetic distances can be estimated by multivariate procedures, such as the Mahalanobis generalized distance (Cruz, Paiva, Neves & Cunha, 2012), the canonical variables, the principal components, among others, and the choice of method is a function of the desired precision, of the ease of analysis and of the way the data are obtained. These studies can be complemented by the Tocher clustering methods and dispersion in Cartesian axes, which employ previously estimated genetic distance matrices. The advantage of the multivariate methods lies in the fact that they allow combining the multiple items of information contained in the experimental unit, enabling the characterization of the treatments based on a complex of variables (Cruz, Regazzi, & Carneiro, 2010).

Thus, the data were submitted to multivariate analysis by Principal Component Analysis (PCA), with the help of the PROC PRINCOMP of SAS (SAS, 2002), to the normality test and homoscedasticity, to analysis of variance, using the F test to diagnose a significant effect ($p<0.05$) and the means, when significant, compared using Tukey's test ($p<0.05$) with the SISVAR software (Ferreira, 2011). The graphs were made using Sigma Plot 11.0 software.

Results and discussion

Multivariate analysis by PCA, used to emphasize the relationship of variances among the characteristics studied in order to relate them by means of graphic dispersion to the response of the seedlings produced with the organic residues, indicates that in the analysis of the data regarding the seedlings 58.0% of the variation is associated with the first principal component, where it was possible to find the following Fisher Linear Discriminant Function (FDF) (Fisher, 1936; Pimentel-Gomes, 2009) (Equation 1):

$$ACP1 = 0.34X1 + 0.34X2 + 0.05X3 + 0.27X4 + 0.21X5 + 0.32X6 + 0.36X7 + 0.31X8 + 0.36X9 + 0.01X10 - 0.24X11 + 0.35X12 \quad (1)$$

Where:

X1 – stem diameter

X2 – plant height

X3 – height/diameter ratio

X4 – leaf number

X5 – total chlorophyll

X6 – leaf area

X7 – dry matter of the aerial portion

X8 – dry mass of root

X9 – total dry mass

X10 – DMAP/DMR ratio

X11 – H/DMAP ratio

X12 Dickson Quality Index.

In the principal component analysis of the response variables described (Equation 1), it was observed that all of them presented a positive sign, except X11. Thus, when there is an increase of 0.34 in variable (X1), all the other variables respond positively, however, the variable (X11) is diminished by 0.24. Thus, in the graphic dispersion, the variance explained by this principal component will tend to approach the seedlings with similar characteristics by resemblance.

The three-dimensional graphic dispersion of the seedlings "*by plot*" with the principal component when the scores of these components are calculated is represented in figure 2. The variables are separated into three response groups, the first including the treatment of the decomposed burity stem, at the proportions of 80% and 20%, respectively, which change the production of the H/DMAP ratio; the second group covers the carnauba straw treatment at the proportions of 20%, 40%, 60% and 80%, respectively, which alter plant growth as to H, H/SD, DMAP/DMR and TC; and the last group covers the treatments with organic composts at doses X, W, Y and Z which alter SD, DQI, DMAP, DMR and TDM (Fig. 2).

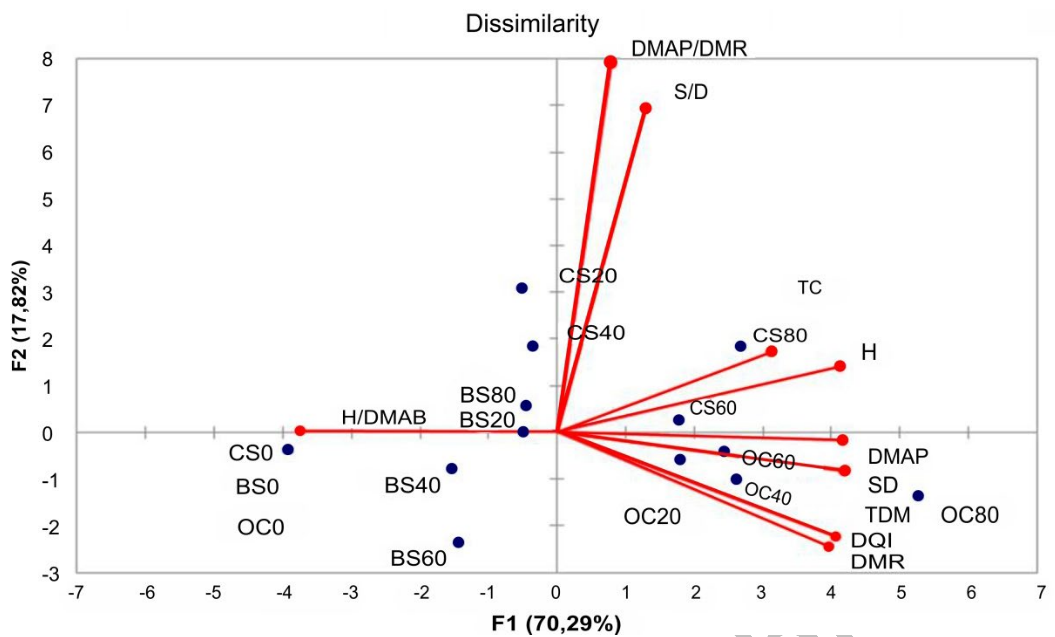

Figure 2. Graphic representation of the principal components analysis (PCA) giving the dimensions 1 and 2 referring to the development of the angico branco plants.

In the dispersion, the seedlings produced in OC:SL at 80% were outstanding with a distinct pattern, while the seedlings produced in the treatment without incorporating organic residues into the soil (100% SL) presented the opposite behavior. With these results it can be observed through the coordinates that there is a resemblance between the seedling produced with the residue, independent of the doses being in a same quadrant or nearby.

Analyzing the Euclidean distance formed between the substrates used in the experiments and the parameters evaluated., it was found that groups were formed regarding the efficiency of angico branco seedling production (Fig. 3). By analyzing the resemblance between the substrates and the hierarchization of the results in relation to the parameters analyzed, two groups were formed, the first consisting only of substrates containing organic residue which was qualitatively superior to the second group formed by substrates containing only soil, thus demonstrating that the addition of organic residues to the soil led to better quality seedlings compared to the treatment without incorporating residues.

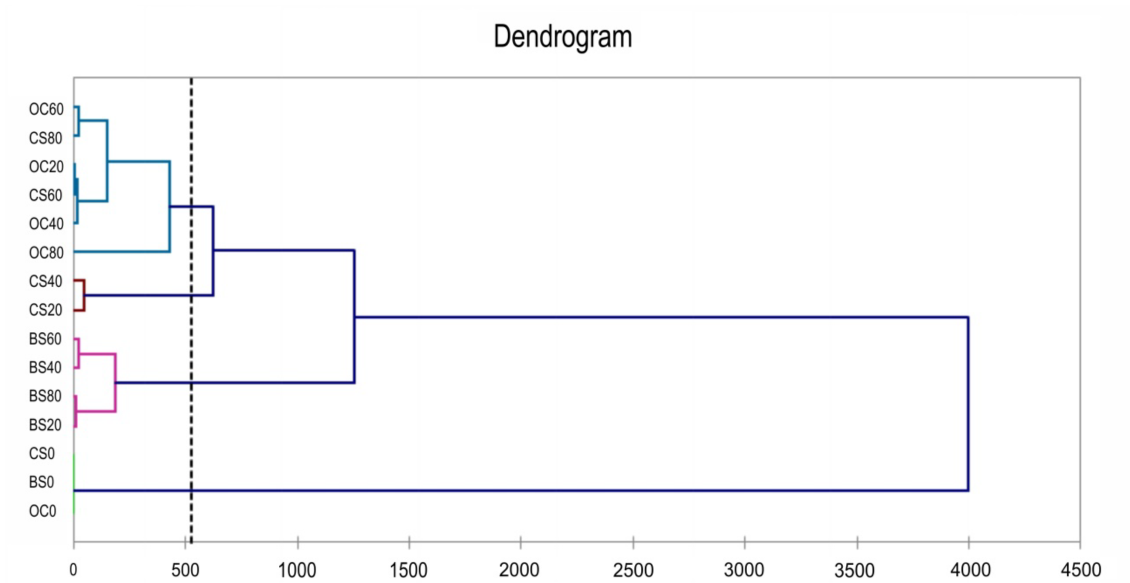

Figure 3**.** Dendrogram with the dispersion of the 15 treatments for the production of angico branco seedlings. CS – carnaúba straw; OC – organic compost; BS – decomposed burity stem; HD –humid density; DD – dry density; WRC – water retention capacity; AS – aeration space; PV – pore volume.

Relations between H/SD, DMAP/DMR and H/DMAP did not present a significant effect. The other growth variables presented an interaction between the sources of organic residues and the dosages, allowing the estimate of maximum points that indicate the best dosages of the substrates for angico branco seedling production.

The results of the analysis of variance demonstrate significant interaction ($p \leq 0.05$) between the factors organic residues and proportions of the composition of substrate for H, SD, LN, DMAP, DMR, TC and DQI, evidencing that the joint action of the factors influenced the expression of these characteristics.

In CS, the best responses for the SD were seen in the substrate with 60 and 80% of the residue in the composition, followed by 20% and 40%, the worst results being obtained in pure soil. In the BS the best result was observed in all substrates except that formed only by pure soil. In the OC at the proportions of 40%, 60% and 80% were observed increments in the SD of 5.07; 4.84 and 5.79 mm, respectively. Among the residues studied, the OC was outstanding among the proportions used for the SD of white angico seedlings, as was the SC at 60 % in the substrate composition (Table 3).

Table 3. Morpho-physiological attributes and quality indexes of angico branco seedlings produced in alternative substrates formed by sources and growing proportions of organic residues.

Substrate %	SD mm	H cm	H/SD –	LN Unit	TC µg cm^{-2}	LA cm^2
	Carnaúba Straw (CS)					
0	1.60 cA	12.50 cA	8.21 aA	20 cA	15.67 cA	44.27 cA
20	2.93 bB	31.67 bAB	11.02 aA	25 bcA	49.82 abA	203.5 bA
40	3.10 bB	28.17 bB	9.53 aA	31 abA	58.80 aA	193.4 bAB
60	4.23 aA	35.67 bB	8.50 aA	37 aA	42.92 abA	413.0 aA
80	4.77 aB	48.67 aA	10.43 aA	28 abcB	39.33 bB	483.1 aA
	Decomposed burity stem (DBS)					
0	1.60 bA	12.50 cA	8.21 aA	20 bA	15.67 bA	44.27 bA
20	3.30 aB	28.50 aB	9.13 aA	26 abA	31.43 abB	182.7 aA
40	2.70 aB	21.00 abcB	8.11 aA	20 bB	37.25 aB	154.7 abB
60	2.86 aB	19.00 bcC	7.06 aA	19 bB	38.62 aA	189.5 aB
80	3.15 aC	25.17 abB	8.71 aA	32 aB	27.28 abB	217.3 aB
	Organic compost (OC)					
0	1.60 cA	12.50 cA	8.21 aA	20 dA	15.67 cA	44.27 dA
20	4.43 bA	38.50 bA	8.75 aA	27 cdA	42.35 abAB	247.0 cA
40	5.07 abA	41.83 abA	8.54 aA	34bcA	42.87 abAB	269.2 bcA
60	4.84 abA	47.13 abA	9.86 aA	39 bA	33.97 bcA	379.0 abA
80	5.79 aA	49.67 aA	8.68 aA	48 aA	60.77 aA	458.5 aA
C.V. (%)	19.0	20.0	31.0	20.7	33.1	35.8

SD - stem diameter; H - Height of the aerial part; H/D - height /diameter ratio; LN - leaf number; TC - total chlorophyll; LF - leaf area. C.V. - coefficient of variation. Means followed by the same letter are not different from each other, according to Tukey’s test at 5%; Lower case letters compare the proportions in each organic residue, and capital letters compare the organic residues in each proportion in the substrate.

According to Gomes and Paiva (2000), the stem diameter is considered one of the most important variables to estimate the survival of forest species seedlings in the field, evaluated both alone and combined with the height (Gomes, Couto, Leite, Xavier, & Garcia., 2002). Similar results were observed by Nóbrega *et al*. (2008), who found a quadratic effect, obtaining the maximum diameter of 3.8 mm in sesbania (*Sesbania virgata*) seedlings, at a proportion of 57% waste compost in the mixture with soil.

Among the residue: soil mixtures studied and the effects of the height of angico branco plants, it was observed that the proportions 80% in CS; 20 and 80% in BS and 40, 60 and 80% in OC resulted in the highest values of this variable. Among the residues studied, the organic compost resulted in the highest values of H in the proportions evaluated, together with CS at 80% of the substrate with values of 49.67 and 48.67 cm, respectively (Table 3).

The positive effect of the organic compost at the estimated dosage on the variable H is related to the conditioning effect that the latter promotes in the composition of the substrate, characterized by its ready availability of nutrients, situated at levels adequate for the development of plants (Table 1). Delarmelina, Caldeira, Faria, & Gonçalves (2013) found that the best growth in the height of *Sesbania virgata* (Cav.) Pers seedlings occurs when they are cultivated in substrates to which organic compost has been added. For the variable H/D there was no significant effect of the organic residues or of their proportion on the substrates (Table 3).

As to the variables involving the aerial part it was observed that among the organic residues studied, there were significant differences, and between their proportions in the substrates (Table 3). The leaf area of a plant depends on the number and size of the leaves, as well as the time it remains active and is related to various physiological processes, such as photosynthesis, respiration and transpiration (Pereira, 1987).

In the substrate composed by CS, the maximum number of leaves (31 and 37 units) was observed at the proportions of 40% and 60%, respectively. In BS, and in OC at the proportion of 80% with 48 units. At the proportion of 80% the OC stands out from the other organic residues in the composition of the substrate for variable LN. However, at the other proportions there was no significant difference between OC and CS (Table 3).

For the TC contents of the angico branco seedlings, the highest values were seen in the substrates composed by CS at the proportions of 20%, 40% and 60%. On the other hand, in those composed by BS there was no significant difference among the proportions, except in the pure soil with the worst results for variable TC and in the substrates composed by CO the best results were obtained at the proportions 20%, 40% and 80% with values of 42.35; 42.87 and 60.77 µg cm^{-1}, respectively. Among the proportions studied except for 80%, the outstanding residues were the CS and the OC (Table 3).

In the substrates composed by CS and OC the highest values for LA were observed at the proportions of 60% and 80%. However, in those with BS in their composition there was no significant difference among the proportions except in the pure soil that presented the lowest value. Among the larger proportions studied 60% and 80%, outstanding in the increase of leaf area of angico branco were the residues, CS and OC (Table 3). Therefore, it is important to observe that the LN, LA and TC are contributing to the greater interception of light and, consequently, greater photosynthesis. This effect is reflected in the other development parameters evaluated, since the growth in height, diameter and increment of aerial and root biomass depend on net photosynthesis (Taiz & Zeiger, 2004).

In table 4 it was seen that for the variable DMAP, the highest values (6.08 and 7.33 g) with the use of CS were at the proportions 60% and 80%, respectively, and for the

DMR) at the proportions between 20 and 80%. However, the results for the TDM were similar to those observed for DMAP, with values of 7.92 g and 9.18 g, respectively. According to Schumacher, Ceconi, & Santana (2004) the highest production of DMAP occurs in the majority of plants with an adequate supply of nutrients, which reflexts the greater fertility of these substrates (Table 1).

Table 4. Morpho-physiological attributes and quality indexes of angico branco seedlings produced in alternative substrates formed by sources and growing proportions of organic residues

Substrate	DMAP	DMR	TDM	DMAP/DMR	H/DMAP	DQI
%	———	g ———		–	–	–
	Carnaúba Straw (CS)					
0	0.52 cA	0.29 bA	0.80 cA	2.54 aA	29.99 aA	0.09 bA
20	2.54 bB	0.63 abB	3.16 bB	4.94 aA	14.93 abA	0.21 bB
40	2.48 bB	0.80 abB	3.28 bB	4.29 aA	13.38 bA	0.30 bB
60	6.08 aA	1.84 aAB	7.92 aA	3.83 aA	6.01 bA	0.67 aA
80	7.33 aB	1.85 aB	9.18 aB	4.61 aA	6.97 bA	0.63 aB
	Decomposed burity stem (DBS)					
0	0.52 bA	0.29 aA	0.80 bA	2.54 aA	29.99 aA	0.09 bA
20	2.95 aB	1.31 aAB	4.27 aB	2.78 aA	11.07 bA	0.36 aB
40	1.62 abB	1.03 aB	2.65 abB	2.13 aA	13.28 bA	0.27 abB
60	1.95 abB	1.36 aB	3.31 aB	1.75 aA	10.36 bA	0.38 aB
80	2.93 aC	1.26 aB	4.19 aC	3.21 aA	9.21 bA	0.38 aC
	Organic compost (OC)					
0	0.52 cA	0.29 cA	0.82 cA	2.54 aA	29.99 aA	0.09 cA
20	5.32 bA	2.26 bA	7.58 bA	2.66 aA	7.29 bA	0.69 bA
40	6.01 bA	2.80 bA	8.81 bA	2.50 aA	7.31 bA	0.83 bA
60	6.01 bA	2.79 bA	8.78 bA	2.44 aA	8.56 bA	0.71 bA
80	9.14 aA	4.17 aA	13.31 aA	2.46 aA	5.44 bA	1.21 aA
C.V.	28.9	56.0	29.0	57.3	64.3	36.5

DMAP - dray mass of aerial part; DMR - dry mass of root; TDM - total dry mass; DMAP/DMR - ratio of dry mass of aerial part and root; H/DMAP - ratio of height of plants and dry mass of aerial part; DQI - Dickson quality index; C.V. - coefficient of variation. Means followed by the same letter are not different from each other, according to Tukey's test at 5%; Lower case letters compare the proportions in each organic residue, and capital letters compare the organic residues in each proportion in the substrate.

In the plants grown in substrates composed of a mixture of BS comparing the proportions, both DMAP and TDM presented the highest values in all mixtures, the lowest value observed in the substrate being formed by pure soil. On the other hand, in the substrates with OC in the mixture, the highest values of DMAP, DMR and TDM were observed at the proportion of 80% (9.14 g; 4.17 g and 13.31 g, respectively). The highest production of DMAP, DMR and TDM was observed at the proportion of 80% with organic compost. Its proportion of 60% equals that of carnauba straw (Table 4). They corroborate the result found by Nóbrega *et al*. (2008) that, evaluating the effect of adding the urban waste and liming in the initial growth of *Enterolobium contortisiliquum* found a higher production of DMAP in the substrate with a proportion of 80:20 (garbage: soil compost).

For variable DMAP/DMR there was no significant effect of organic residues or of their proportions on the substrates. However, at the ratio of H/DMAP the worst results were observed in the smaller proportions of residues in the mixtures, which confirms the importance of using an organic source in the composition of the substrates to produce seedlings of forest species (Table 4).

According to Cruz *et al*. (2010) the yields of DMAP, DMR and TDM are considered good parameters for the evaluation of seedling quality, since they indicate their rusticity, in other words, plants with a greater accumulation of biomass are more resistant to adverse conditions in the field and, consequently, have a greater survival rate (Gomes & Paiva, 2006). The values observed can be explained by the phosphorus, potassium and magnesium contents present in these substrates, as shown in table 1. Moreover, the organic residues act as soil conditioners and thus improve the physicochemical properties of soil or substrate (Prezotti, Gomes, Dadalto & Oliveira, 2007).

According to Fonseca, Valéri, Miglioranza, Fonseca, & Couto (2002), the DQI is considered an important indicator of seedling quality, since in its calculations it weighs the results of important parameters such as robustness and equilibrium of biomass distribution in the seedling, and the higher its value, the better the seedling quality (Bernardino, Paiva, Neves, Gomes, & Marques, 2005).

The DQI of the seedlings grown in the substrates composed by the CS were higher at the proportions of 60% and 80% (0.67 and 0.63, respectively), followed by the other treatments. In the seedlings grown in the mixtures containing (BS), the values of DQI at the proportions studied were not different from each other, except for the control which presented the worst results and in the substrate with organic compost the highest value (1.21) for DQI was observed at the proportion of 80%, followed by proportions 20%, 40% and 60% and the lowest value in pure soil. In the deployment of the residues within the percentages, the highest value of DQI was observed in the organic compost at a proportion of 80%, followed by CS, and the worst result for the decomposed stem of burity. However, at a proportion of 60%, the highest values were observed in CS and in OC, and at the proportions of 20% and 40% the highest values were in the substrates with OC (Table 4).

The results evidence that, generally, for most of the morphophysiological variables evaluated, the proportion of organic residues in the composition of the substrates at 80%, followed by 60%, provided the highest means, which is explained both by the chemical composition of the organic residues and by the direct benefits on the fertility of substrates of cultivated plants.

Hence, the use of organic wastes is a feasible and sustainable alternative for the production of angico branco seedlings, since they have a low cost, because they are prepared from materials or residues available on farms, which add greater qualities to the seedlings and, consequently, to the farmer's earnings.

Conclusions

Angico branco seedlings are responsive to the addition of organic residues to the substrate. The proportions of 60% and 80% of the organic compost or carnauba straw in the substrate are most appropriate to maximize the production of angico branco seedlings. The organic compost is the best among the organic residues studied. The highest Dickson quality index of seedlings is obtained using the organic compost at a proportion of 80%.

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