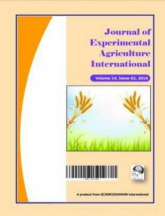

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Different Substrates in Seedling Production of *Caesalpinia pyramidalis* Tul

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Authors' contributions

This work was carried out in collaboration with all authors. This study is part of the course conclusion work of author NNGMC, who together with authors JCAN and RSAN designed the study, wrote the protocol and the first draft of the manuscript. Authors ECP and FPMD managed the analyses of the study and performed the statistical analysis. Author FTSS reviewed and translated every manuscript. All authors read and approved the final manuscript.

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ABSTRACT

The use of native species for the recovery of degraded areas has been of great relevance, however, there is a deficiency in studies aimed at the Northeast region of Brazil, which presents one of the largest areas under desertification in the South American continent. The region has a diverse native flora of high cultural and economic relevance such as *Caesalpinia pyramidalis* Tul, popularly known as catingueira that stands out for the rusticity and use in diverse areas medicinal, logging, cultural,

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animal feeding, among others. The objective of this work was to evaluate the effects of chemical fertilisation on different substrate sources on the emergence and initial growth of *Caesalpinia pyramidalis* seedlings. For the constitution of the substrates samples, Yellow Oxisol distrocoeso were collected at 0.50 m depth and superfine vermiculite. Also organic manure and organic compound were used. The emergence and morphological features (area and total dry mass, height, diameter, chlorophyll A and B) were evaluated. The seedlings of *Caesalpinia pyramidalis* placed on substrates consisting of organic compound in the ratio 1:1:1 (compound: soil: vermiculite) and 2:1:1 (compound: soil: vermiculite) and cattle manure 2:1:1 (manure: soil: vermiculite) generated satisfactory results for the development of the crop. There was no interaction ($p > 0.05$) between the addition of NPK and the types of substrates evaluated for the studied variables.

Keywords: Catingueira; desertification; substrates.

1. INTRODUCTION

The semi-arid region of northeastern Brazil, with an area of 982,563.3 km², corresponds to about 11% of the Brazilian territory, presenting hot and humid climate which is divided in to two seasons. The rainfall of this region ranges from 300-800 mm (occurring irregularly between three to four months of the year [1]. Due to this phenomenon the drought is the local reality, closing the water balance for most of the negative year.

The soils of the semi- arid region are shallow and poorly developed, as a result of the climatic factors which plays the major role in the soil formation of the region, thus limiting the development of plants. All these adversities induce desertification, a process resulting from several factors that may or may not be instigated by human action [2].

Catingueira (*Caesalpinia pyramidalis* Tul), also known as, catinga-de-porco, pau-de-porco or pau-de-rato, is a species of the subfamily *Caesalpiniaceae*, of medium size, ranging from 2 to 10 m, which propagates through seeds, produced annually [3]. It is one of the most rustic and versatile legumes in the Northeast region of Brazil, being used in several areas such as medicinal, logging, cultural and animal feeding, among others. Because it exudes a very strong smell, mainly in the reproductive period where its seeds are formed, this characteristic keeps the animals apart which keeps the plant intact, thus favouring the soil cover, but when its cycle ends and the leaves dries up, serve as food for food for animals [4,5].

In the area of medicine, it is use in the treatment of wounds and abnormal digestive conditions. In the animal environment, its flowers provide food for the bees that ensure the visitation of pollinators in the area, furthermore the stem are used for firewood, and the leaves for hay when dried protein content that guarantees animal feed in the dry season, which can also be stored as hay [6]. The by-product of the plant are used for dye production and insecticide formulation [7,8].

In general, studies that complement the knowledge about the use of organic substrates and proportions to favour the germination and development of seedlings of native forest species are essential for the production of quality seedlings, and consequent success in the field after its transplanting. Studies have shown that catingueira seedlings were favoured when submitted to substrates consisting of soil, sand and manure [9], as well as by substrates consisting of sand and vermiculite under temperatures of 20-30 and 20-35°C, in this case, in tests of germination in catingueira seeds [10]. There are also indications positive for the use of substrates consisting of vegetal soil and vegetal soil plus sand [11].

The objective of the present work was to evaluate the influence of chemical fertilisation and the effect of different sources of organic substrates on the emergence and initial growth of *Caesalpinia pyramidalis* Tul.

2. MATERIALS AND METHODS

The experiment was conducted in a greenhouse at the Center for Agrarian, Environmental and Biological Sciences of the Federal University of Recôncavo da Bahia - UFRB, Cruz das Almas campus, Bahia, Brazil, geographically located at latitude 12º40 '12 "S and longitude 39º 06 '07 "W. In the region predominate Dystrophic Yellow Ultisol and Oxisol. The average annual temperature is 24.2°C with a climate according to the classification of Köppen, type Af, ie hot climate, with the coldest month with temperature above 18°C and the driest with equal

Table 1. Scheme used for separation of fertilised and unfertilised treatments to evaluate the emergence and early development of seedlings of *Caesalpinia pyramidalis Tul*

Treatments fertilised	Treatments unfertilised
TRAT 1- Organic Compound – (1:1:1)	TRAT 1- Organic Compound – (1:1:1)
TRAT 2- Cattle Manure– (1:1:1)	TRAT 2- cattle manure – (1:1:1)
TRAT 3- Organic Compound – (2:1:1)	TRAT 3- Organic Compound – (2:1:1)
TRAT 4- Cattle Manure – (2:1:1)	TRAT 4- Cattle Manure – (2:1:1)
TRAT 5-Witness	TRAT 5- Witness

precipitation or greater than 60 mm; the average annual rainfall is 1,200 mm, with the months from March to July being the rainiest and October and January being the driest.

The study was carried out with the species *Caesalpinia pyramidalis* Tul, popularly known as catingueira, being the seeds coming from matrices located in the region of the municipality of Santa Teresinha, Bahia. For the constitution of the substrates samples of a Yellow Oxisol distrocoeso were collected at 0.50 m depth and superfine vermiculite. As organic waste cattle manure and organic compound were used.

The treatments consisted of a 5x2 factorial arrangement, represented by the combination of proportions of organic compost, soil and vermiculite and manure, soil and vermiculite, with and without the application of chemical fertilisers (Table 1), totaling 10 treatments with five replications, arranged in one completely random design.

The soil and the organic substrate was sieved in a 4 mm mesh, then mixed according to the proportions of each treatment. The containers were manually filled with the previously mixed materials, with substrate compaction observed, the containers being used polyethylene bags with dimensions 18 x 25 cm.

For treatments receiving addition of chemical fertilisers (N, P and K), were applied at the dose of 75.5 mg plant^{-1} for nitrogen, 258.6 mg plant^{-1} potassium and 2.2 g plant^{-1} for phosphorus, with N and K being divided into two applications, using urea, single superphosphate and potassium chloride as sources of fertilisation. During the experimental period, the moisture content of the treatments was maintained through daily irrigation, always kept in conditions close to the field capacity.

The emergence was evaluated in the first 16 days after sowing, using seedlings with cotyledons above ground level as the criterion. At 120 days after sowing, the morphological variables were: shoot height, shoot diameter, dry root mass, dry shoot mass, total dry mass, chlorophyll A, B and total index, leaf number and index of Dickson quality (IQD).

The results were submitted to analysis of variance using the statistical program SISVAR [12]. For the variables that presented significant differences, the Scott-Knott test was used at a 5% probability level.

3. RESULTS AND DISCUSSION

There was no significant interaction between treatments with and without chemical fertilisers for any of the variables evaluated in *C. pyramidalis* seedlings. The treatments studied did not influence the emergence of *C. pyramidalis* seeds (Table 2). This was in contrast with the report by Lima et al. [10] who observed that plants of *C. pyramidalis* produced on substrates consisting of sand and vermiculite with controlled temperature between 20 and 35°C presented 71% of emergence.

Treatments constituted of organic compound in ratios 1:1:1 and 2:1:1 and cattle manure in the proportion 2:1:1, presented Chlorophyll A, B and total contents higher than the other treatments (Table 2). Chlorophyll is a plant pigment that reflects greenish coloration and is closely related to the photosynthetic activities of plants. The higher these activities, the greater the plant development, because the responses are associated with the use of radiation and nutrient levels in plants [13].

Aerial dry matter mass (MSPA), total dry matter mass (MST) and number of leaves (NF), provided satisfactory results for all *C. pyramidalis* seedlings grown on substrates containing organic compound in proportions (1:1:1 and 2:1:1) and cattle manure (2:1:1). For the dry matter of root (MSR) there was no significant difference ($p > 0.05$). It is important to highlight that, although the treatments in the proportions

1:1:1 and 2:1:1 of organic compost do not obtain significant difference for the chlorophyll content, area mass, total dry matter mass and leaf number, the ratio 1:1:1 should be used, since there is a greater saving for the producer, therefore, he will use a smaller quantity of organic compound.

Seedlings of *C. pyramidalis* grown on different substrates under shading conditions produced MSPA between 1.18 and 1.57 g plant^{-1}, averages below those presented in the present study, except for the control treatment (Table 3), which may be related not only to the culture time, but also to substrate quality [9]. For MST, Dantas et al. [4] observed in *C. pyramidalis* seedlings produced by different substrates and luminosities, that after 100 days the seedlings presented MST values between 0.49 and 1.28 g, values lower than those found in this study.

The MST is a variable that must be taken into account because it represents the efficiency and quality of the seedling produced, that is, the higher the average, the better the seedling attributes [14]. Gomes and Paiva [15] emphasise this variable as indicator of quality and rusticity of seedlings, being parameter of resistance and survival of the same in the field. In the present study the substrates formulated with organic compound in proportions 1:1:1 (a part of soil vermiculite, substrate) and 2:1:1 (two parts of soil, one of vermiculite and one of substrate) may be indicated for the production of *C. pyramidalis* seedlings.

The substrates consisting of cattle manure in the ratio (1:1:1) and the control did not increase the NF of the *C. pyramidalis* seedlings (Table 3). Dantas et al. [4] observed significant results in seedlings of *C. pyramidalis* presenting their highest average 5.6 when they were submitted to 50% of luminosity and cultivated in substrate composed of sand and manure, a value higher than that of the present study for control treatments and cattle manure in the ratio 1:1:1. It should be emphasised that NF is directly linked to photosynthetic activity, consequently, to the development of the plant, taking into account that the leaves are also used as a storage site for reserves.

The best height (H) and diameter (D) averages for seedlings were recorded on substratum crops consisting of 1:1:1 and 2:1:1 organic compost and cattle manure in the ratio of 2:1:1. Comparing with the work of Antunes et al. [11] that evaluated the seedlings of *C. pyramidalis* submitted to different substrates and luminosity evaluated after six months of sowing verified values referring to H between 16.0 and 46.1 cm. [16], testing the germination and production of *C. pyramidalis* seedlings in biosaline water during a period of 120 days, verified a higher average of 10 cm of H similar to those found in this study, except for the control treatment. Lustosa Filho et al. [17] working with different substrates for the production of jatobá seedlings, verified that the use of substrate composed of carnauba bagana consisting of a compound produced from a mixture of tree pruning residues, coconut husk fiber and cattle manure, together with sifted Quartzarenic Neosol soil samples, promoted greater increase in shoot, root and total dry matter mass and increase in plant height. Demonstrating, as in the present study, that the use of organic compost is adequate for the production of forest seedlings.

Table 2. Seed emergence and chlorophyll indices of *Caesalpinia pyramidalis* seedlings grown on organic substrates

Substrates[1]	Emergency	Chlorophyll		
	(%)	A	B	total (A+B)
COM 1:1:1	83.10 a	33.15 a	12.76 a	45.92 a
COM 2:1:1	64.20 a	33.90 a	13.08 a	46.98 a
EST 1:1:1	74.33 a	25.75 b	7.07 b	32.82 b
EST 2:1:1	80.77 a	36.91 a	14.77 a	51.68 a
TEST	74.60 a	29.44 b	8.96 b	38.40 b
CV %	31.29	19.42	37.50	21.54

1COM 1:1: substrate consisting of soil with vermiculite and organic compound in the proportion of 1:1 (v : v), COM 2:1: substrate consisting of soil with vermiculite and organic compound in the proportion of 2:1 (v : v); EST 1:1: substrate formed with vermiculite soil and cattle manure in the proportion of 1: 1 (v : v); EST 2:1: soil consisting substrate with vermiculite and cattle manure in the proportion of 2:1 (v : v); TEST: control treatment. Means followed by equal letters in the column did not differ significantly from each other by the Scott-Knott test (p <0.05)

Table 3. Mean dry matter of the aerial part (DMAP), root (MSR) Total (MST) and leaf number (NF) of *Caesalpinia pyramidalis* seedlings grown on organic substrates

TRAT[1]	MSPA	MSR	MST	NF
	---------- g plant^{-1} ----------			
COM 1:1:1	2.57 a	1.56 a	4.13 a	7.60 a
COM 2:1:1	2.56 a	1.71 a	4.27 a	6.80 a
EST 1:1:1	1.16 b	0.96 a	2.12 b	5.22 b
EST 2:1:1	3.04 a	1.93 a	4.97 a	8.00 a
TEST	1.16 b	1.16 a	2.33 b	4.90 b
CV%	60.51	66.15	56.64	32.55

[1]COM 1:1: substrate consisting of soil with vermiculite and organic compound in the proportion of 1:1 (v:v), COM 2:1: substrate consisting of soil with vermiculite and organic compound in the proportion of 2:1 (v:v); EST 1:1: substrate consisting of soil with vermiculite and cattle manure in the proportion of 1:1 (v : v); EST 2:1: substrate consisting of soil with vermiculite and cattle manure in the proportion of 2:1 (v:v); TEST: control treatment.
** Means followed by equal letters in the line did not differ significantly from each other by the Scott-Knott test (p <0.05)*

Table 4. Mean height (H), diameter (D), height in relation to diameter (H : D) and Dirckson quality index (IQD) of *Caesalpinia pyramidalis* seedlings grown on organic substrates at 120 days

TRAT [1]	H	D	H:D	IQD
	(cm)	(mm)		
COM 1:1:1	13.43 a	3.88 a	3.46 a	0.82 a
COM 2:1:1	13.79 a	3.97 a	3.47 a	0.85 a
EST 1:1:1	10.37 b	3.05 b	3.40 a	0.49 a
EST 2:1:1	15.28 a	3.79 a	4.03 a	0.49 a
TEST	8.74 b	3.13 b	2.79 a	0.60 a
CV%	34.09	16.00	30.60	

[1]COM 1:1: substrate consisting of soil with vermiculite and organic compound in the proportion of 1:1 (v:v), COM 2:1: substrate consisting of soil with vermiculite and organic compound in the proportion of 2:1 (v:v); EST 1:1: substrate consisting of soil with vermiculite and cattle manure in the proportion of 1:1 (v:v); EST 2:1: substrate consisting of soil with vermiculite and cattle manure in the proportion of 2:1 (v:v); TEST: control treatment.
** Means followed by equal letters in the line did not differ significantly from each other by the Scott-Knott test (p <0.05)*

The seedlings of *C. pyramidalis* grown in biossaline water by Ribeiro et al. [16] showed values of stem diameter (D) between 0.11 and 0.13 mm, values below those found in the present study (Table 4). In general, D is the criterion observed to evaluate the quality of seedlings of forest species to maintenance and development indices in the crop [18].

For the relation between stem height and diameter (H:D) and the Dickson Quality Index (IQD) there was no significant difference between the tested substrates.

The values of H:D present lower results in relation to the range indicated as adequate by Aries [19], which considers as a default value the interval between 5.4 to 8.1, when this standard is not reached the recommended one is that the molt remains in the nursery for a possible increase of this relation. Generally, this variable expresses the quality of the seedling at any stage of production.

The IQD showed to be relevant evidencing values above the reference stipulated by Gomes and Paiva [15]. The authors show that the minimum value for IQD is 0.20. Based on this principle, the results generated in this study remain within the quality index, that is, all the substrates used are suitable for the production of quality seedlings.

The results expressed in the present study reveal that the use of organic compost and cattle manure favours the initial growth of *C. pyramidalis*. It is also emphasised that the use of organic substrates not only contributes to the development of seedlings but also favors the

reuse of organic materials from rural properties, reduction of environmental pollution and reduction in the use of external inputs to property, as well as improvements in (1998), which is based on the physical, chemical and biological properties of the soil [20,21].

4. CONCLUSIONS

The *Caesalpinia pyramidalis* seedlings were not influenced by the addition of NPK in the proportions of cattle manure and organic compost.

The use of organic compost in 1:1:1 and 2:1:1 ratios increased chlorophyll A, B and total contents, total dry matter, root and aerial yield, as well as stem height and diameter. Therefore the ratio of 1:1:1 is recommended.

For cattle manure, the same effect of the organic compound was also verified, but only in 2:1:1 ratios.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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