







GROWTH RESPONSE OF *Bauhinia Variegata* L. TO INOCULATION AND ORGANIC FERTILIZATION¹

Caliane da Silva Braulio^{2*} , Rafaela Simão Abrahão Nóbrega³ , Flávia Melo Moreira⁴ , Ângela Santos de Jesus Cavalcante dos Anjos⁵ , Janildes de Jesus da Silva⁶  and Juan Manuel Anda Rocabado² 

¹ Received on 06.04.2018 accepted for publication on 28.03.2019.

² Universidade Federal do Recôncavo da Bahia Programa de Pós-Graduação em Solos e Qualidade de Ecossistemas, Cruz das Almas, BA - Brasil. E-mail: <caliane.braulio@gmail.com> and <quirito2000@yahoo.com.br>.

³ Universidade Federal do Recôncavo da Bahia, Centro de Ciências Agrárias, Cruz das Almas, BA - Brasil. E-mail: <rafaela.nobrega@gmail.com>.

⁴ Universidade Federal do Recôncavo da Bahia Programa de Pós-Graduação em Agronomia, Cruz das Almas, BA - Brasil. E-mail: <fmmoreira_ef@yahoo.com.br>.

⁵ Universidade Federal do Recôncavo da Bahia Graduada em Agroecologia, Cruz das Almas, BA - Brasil. E-mail: <angelasjca@hotmail.com>.

⁶ Universidade Federal do Recôncavo da Bahia, Cruz das Almas, BA - Brasil. E-mail: <janildesdejesus@hotmail.com>.

*Corresponding author.

ABSTRACT – The objective of this work was to evaluate the initial growth of *Bauhinia variegata* L. when inoculated and fertilized with different proportions of organic compost. The experiment was performed in greenhouse in a completely random factorial (2 x 5) + 1 design, with 9 replicates, constituted by the presence or absence of inoculation, five proportions of organic compost:soil (0:100, 20:40, 40:60, 60:40 and 80:20; v/v) and one additional treatment with chemical fertilization without inoculation. Ninety days after sowing, the plant height, stem diameter, number of leaves, radicular length, dry mass of the aerial portion, dry mass of roots, total dry mass, Dickson's quality index (IQD), contents of nitrogen and carbon and the C/N ratio of the dry mass of the aerial portion, were evaluated. The inoculation with diazotrophic bacteria stimulated growth in height, stem height/diameter ratio, dry mass of the aerial portion, dry mass of roots, total dry mass and the foliar contents of nitrogen and carbon in seedlings of *B. variegata* L. Seedlings grown using organic compost showed better development when compared to seedlings grown only in soil with or without chemical fertilization. Seedlings grown with formulated substrate at a proportion of 16:84 (organic compost:soil + inoculation) exhibited higher IQD, therefore, this constitutes the recommended proportion for production of *B. variegata* L. seedlings.

Keywords: Plant growth promoting bacteria; Organic compost; Seedling production.

CRESCIMENTO DE BAUHINIA VARIEGATA L. EM RESPOSTA A INOCULAÇÃO E FERTILIZAÇÃO ORGÂNICA.

RESUMO – Objetivou-se avaliar o crescimento inicial de *Bauhinia variegata* L. em função da inoculação e adubação com diferentes proporções de composto orgânico. O experimento foi conduzido em casa de vegetação, sendo disposto em delineamento experimental inteiramente casualizado em arranjo fatorial (2 x 5) + 1, com 9 repetições, constituídos da presença e ausência de inoculante, cinco proporções de composto orgânico:solo (0:100, 20:40, 40:60, 60:40 e 80:20; v/v) e um tratamento adicional com adubação química sem inoculante. Após 90 dias da semeadura, avaliaram-se: a altura, o diâmetro do colo, o número de folhas, o comprimento radicular, a massa seca da parte aérea, da raiz e total, o índice de qualidade de Dickson (IQD), os teores de nitrogênio e carbono e a relação C/N da massa seca da parte aérea. A inoculação de bactérias diazotróficas estimulou o crescimento em altura, a relação entre altura e diâmetro do caule, massa seca da parte aérea, raiz e total, e os teores de nitrogênio e carbono foliares das mudas de *B. variegata* L. Mudas cultivadas com composto orgânico apresentaram melhor desenvolvimento em relação às cultivadas em solo com e sem adubação química. As mudas cultivadas com o substrato formulado com a proporção de 16:84 (composto orgânico:solo + inoculação) apresentaram maior IQD, sendo, portanto, essa proporção recomendada para a produção de mudas de *B. variegata* L.

Palavras-Chave: Bactérias promotoras de crescimento vegetal; Composto orgânico; Produção de mudas.



1. INTRODUCTION

Organic residues from agricultural or urban activities, after being processed by composting, render an organic material with desirable characteristics to produce substrates for seedling production. Positive results obtained by mixing residues are observed in arboreal species (Duarte and Nunes, 2012; Sousa et al., 2013; Cavalcante et al., 2016; Medeiros et al., 2017). In addition to a significant reduction of environmental pollution through an adequate destination of residues, the use of organic residues contributes for crop production enabling the recycling of residues (Rodrigues et al., 2011) and the reduction of expenses with plant production.

Thus, the use of residues produced in farms and originated from agricultural and urban activities, such as prune of trees, manure and food residues, may contribute to aggregate value to the agricultural activity, through their employment as conditioners or fertilizers in growth substrates.

In addition to the quality of the growth substrate, which depends on its nutrient availability (Delarmelina et al., 2014; Sousa et al., 2016; Krefta et al., 2017) and its physical attributes (Medeiros et al., 2017); the association or symbiosis between plants and bacteria may enhance the development of seedlings in the nursery (Ferreira et al., 2015; Freire et al., 2017; Porto et al., 2017) and in field conditions, when associated to organic substrates (Fernandes et al., 2017).

Bauhinia variegata L. is an exotic fast growing leguminous species, belonging to the family Fabaceae and commonly known as cow's hoof (Krefta et al., 2017). It is considered a medicinal plant, once it shows phytotherapeutic effects and contains phenolic compounds with anti-oxidant properties (Nascimento et al., 2011). This species is widely used for foresting and recovering of degraded land (Lorenzi, 2008). Previous studies showed that species from this genus have positive responses to organic fertilization (Duarte and Nunes, 2012; Fernandes et al., 2015). There are literature data registering the use of cow urine at 5% concentration influencing the growth of *Bauhinia forficata* (Raulino et al., 2015). However, there is no information regarding the nodulation of the genus *Bauhinia*, neither studies demonstrating the effects of growth promoting bacteria in *B. variegata* L. The evaluation of easy available and alternative substrates, in conjunction with inoculation of growth promoting bacterial, is significant

when aiming the production of quality seedlings in shorter periods in the nursery. In such context, the objective of this work was to evaluate the initial growth of *B. variegata* L. when inoculated with growth promoting bacteria and fertilized with organic compost.

2. MATERIAL AND METHODS

The experiment was performed in a nursery at the Agriculture, Environment and Biological Sciences Center from the Federal University of the Recôncavo da Bahia (UFRB), in the city of Cruz das Almas, state of Bahia, located at South latitude 12° 40' 19" and West longitude 39° 06' 23", set up under a completely random design with $(2 \times 5) + 1$ factorial scheme and 9 replicates. The treatments were constituted by two dosages of inoculant (absence and presence of inoculant), five proportions of organic compost:soil (0:100, 20:40, 40:60, 60:40 and 80:20) (v/v), and one additional treatment with chemical fertilization without inoculation, with a total of 99 experimental units. The soil used in the substrates was a dystrophic Red Latosol collected at the UFRB Campus at a depth of 40 cm. Organic compost was also produced at the UFRB, in a compost heap composed by pruned trees and cattle and goat manure, at a 3:1:1 ratio.

Soil and organic compost were dried and sieved through a 4 mm mesh, homogenized and conditioned in plastic bags with 0,12 x 0,23 m and volume of 1,2 dm³. The additional treatment was constituted by 100 mg dm⁻³ of nitrogen (urea as source), 100 mg dm⁻³ of potassium (potassium chloride as the source) and 150 mg dm⁻³ of phosphorus (simple superphosphate as source).

Chemical characterization of the soil and the compost was performed at the Soil Sciences laboratory from the University of São Paulo – ESALQ and was described as: pH (H₂O): 5.2; pH (CaCl₂): 4.5; P: 11.2 mg dm⁻³; K⁺: 74 mg dm⁻³; Ca²⁺: 0.8 cmol_c dm⁻³; Mg²⁺: 0.4 cmol_c dm⁻³; Al³⁺: 0.3 cmol_c dm⁻³; Potential acidity: 2.6 cmol_c dm⁻³; Sum of bases: 1.4 cmol_c dm⁻³; T: 4 cmol_c dm⁻³; Basis saturation: 35%; MO: < 14.4 g kg⁻¹. Chemical attributes of the organic compost were described in humid basis: pH (H₂O): 7.0; pH (CaCl₂ 0.01 M): 6.4; Density: 1.00 g cm⁻³; Humidity at 60 - 65°C: 12.03 (%); Humidity at 110°C: 0.69%; Organic Matter: 10.64%; Organic Carbon: 5.27%; Total Mineral Residue: 76.64%; Mineral Residue: 5.76%; Non-soluble Mineral Residue: 70.88%; Total Nitrogen: 0.62%; Total Phosphate: 0.20%; Total

Potassium: 0.22%; Total Calcium: 0.50%; Total Magnesium: 0.11%; Total sulfur: 0.02%; C/N ratio: 9; Copper: 13mg kg⁻¹; Manganese: 112mg kg⁻¹; Zinc: 31mg kg⁻¹; Boron: 206 mg kg⁻¹; Sodium: 725 mg kg⁻¹.

Seeds of *B. variegata* were collected and separated by size, obtaining a uniform batch from 15 matrices from the county of Cruz das Almas-BA, Brazil. Seeds were manually selected and disinfected in pure ethanol for 5 seconds and sodium hypochlorite 1% for 2 minutes, followed by successive washes in sterilized distilled water and finally submerged in ethylic alcohol for 15 minutes to overcome seed dormancy (Smiderle and Luz, 2010). Subsequently, seeds were inoculated with diazotrophic bacteria.

The inoculum was prepared in peat using a mixture of diazotrophic bacterial inocula authorized by the Ministry of Agriculture, Livestock and Supply (Brasil, 2011). The strains used were INPA 0311B and UFLA 0384 (Lacerda et al., 2004), recommend for *Vigna unguiculata*, and the strain UFLA 03164 (still in evaluation stage). These strains were used to verify nodulation and/or growth promotion ability on *B. variegata*.

The bacteria were multiplied in semi-solid YMA medium, also denominated 79, incubated in BOD chamber for 6 days at 30°C. The inoculum mixture was constituted by the addition of 3.0 mL of mediums containing the strains INPA 0311B, UFLA 0384 and UFLA 03164 with approximately 10⁸ UFC mL⁻¹ each. Then, peat was added at a volume of three parts per part of inoculum. Finally, after inoculation, the sowing was performed with five seeds per bag at 2.0cm depth. Thirty days after sowing, thinning was executed leaving only one plant per bag. Irrigation was performed daily according needed, aiming to simulate the conditions of commercial nurseries.

Ninety days after sowing, seedlings were evaluated for: height (H), stem diameter (ST), number of leaves (NL), root length (RL) and number of nodules (NN). Seedlings were divided in two parts: aerial portion and roots; dried in a forced air drying oven at 65 °C until a constant mass was verified. Then, parts were measured and the dry mass of the aerial portion (DMAP), dry mass of roots (DMR), total dry mass (TDM), ratio between stem high and stem diameter (H/DC) and the Dickson's quality index (IQD) (Dickson et al., 1960), were evaluated. The dry mass of the aerial portion was used to determine the contents of nitrogen (N) and carbon (C) by the

method of dry combustion in an Elementar Vario El (LECO, EUA) analyzer, at the laboratory of Soil and Vegetal Tissue Analyses from Embrapa Semi-arid. The carbon/nitrogen ratio (C/N) was then determined.

Data was submitted to a variance and polynomial regression analyses, according to the proportions of organic compost and dosages of inoculant, using the statistical software SISVAR (Ferreira, 2014).

3. RESULTS

Nodules were not observed in the radicular system of *Bauhinia variegata* L. seedlings cultivated in the evaluated substrates.

Interaction ($p < 0.01$) between the proportions of organic compost with and without inoculant was verified for the variable of plant height (H), showing a quadratic behavior (Figure 1A). The organic compost stimulated growth (in height) of the seedlings, both in the presence and absence of the inoculant. With inoculation, a maximum H of 12.02 cm plant⁻¹ was observed in plants cultivated with substrate constituted of 29:71 (organic compost:soil). In the absence of inoculant the substrate constituted of 9:91 (organic compost:soil) resulted in a maximum of 11.07 cm plant⁻¹ (Figure 1A).

Seedling increase in H was enhanced with the use of organic compost:soil + inoculation up to 54.31%, when compared to seedlings cultivated only in soil (0:100 v/v). Seedlings cultivated in substrate with chemical fertilization (additional control) showed lower mean values (10.86 cm plant⁻¹) that the other treatments (Figure 1A). Regarding the stem diameter (SD), there was individual effect ($p < 0.01$) of the organic compost:soil proportions. The estimated proportion of 22:78 (organic compost:soil), resulted in maximum SD of 2.47 mm plant⁻¹, being 28.34% higher when compared to the substrate constituted only by soil (0:100 v/v) (Figure 1B). Seedlings cultivated in substrate with chemical fertilization showed lower SD (2.23 mm plant⁻¹), when compared to organic compost (Figure 1B).

As regards to the number of leaves (NL) and root length (RL), there was individual effect ($p < 0.01$) of the organic compost proportions. The substrate elaborated with organic compost provided a maximum NL of 5.01 leaves plants⁻¹, for an estimated proportion of 19:81 (organic compost:soil) with an increment of 59%, when compared with the substrate constituted only by soil (0:100 v/v) (Figure 2A). Chemical fertilization

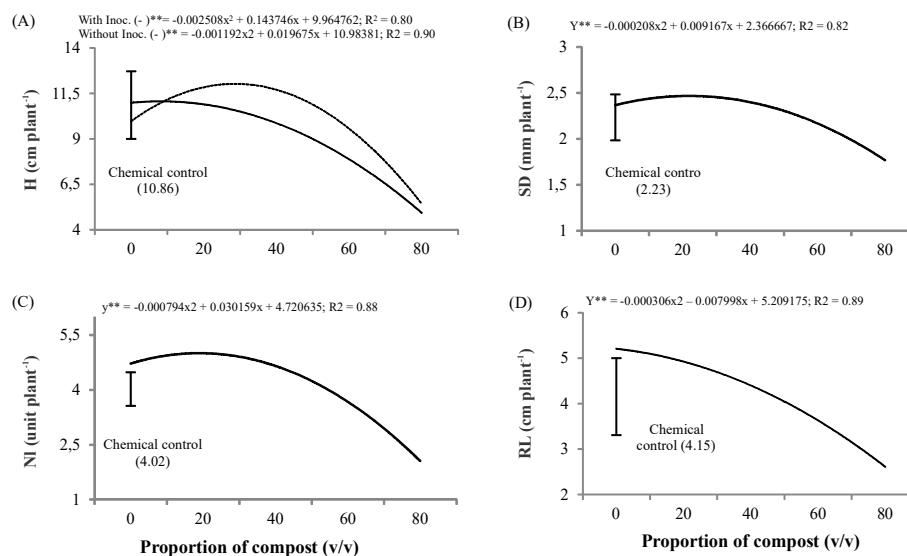


Figure 1 – Height, (H) (A); stem diameter, (SD) (B); number of leaves, (NL) (C) and radicular length, (RL) (D) of *Bauhinia variegata* seedlings cultivated in different proportions of organic compost made from pruned trees supplemented with cattle and goat manure, with (□) or without (■) inoculant and chemical fertilization, 90 days after sowing
Figura 1 – Altura, (H) (A); Diâmetro do caule, (SD) (B); Número de folhas, (NL) (C) e Comprimento radicular (RL) (D) das mudas de *Bauhinia variegata* cultivadas em diferentes proporções de composto orgânico oriundo da poda de árvores acrescido de esterco bovino e caprino, com (□) ou sem inoculante (■) e adubação química aos 90 dias após a semeadura.

showed a lower mean value for NL (4.02 leaves plants⁻¹), when compared to the organic compost (Figure 1C).

The estimated proportion of 14:86 (organic compost:soil), resulted in a maximum RL of 5.26 cm plant⁻¹ (Figure 1D). Plants cultivated with chemical fertilization showed mean value of 4.15 cm plant⁻¹, thus the use of organic compost resulted in an increase of up to 49.90% in RL of *B. variegata* seedling when compared to chemical fertilization (Figure 1D).

Concerning H, beyond the estimated proportions of 29:71 and 9:91 (organic compost:soil), for inoculated and non-inoculated treatments, respectively, a reduction of the mean values was observed (Figure 1A). A reduction was also verified for SD, NL and RL beyond the maximum proportions estimated for each of variable (Figure 1 B, C and D).

Evaluations of dry mass and IQD showed individual effect of the proportions of organic compost:soil and inoculation, all elucidated by a quadratic behavior. There was individual effect ($p < 0.01$) of organic compost proportions with and without inoculation for the dry mass of the aerial portion (DMAP) (Table 1). The estimated proportion of 19:81 (organic compost: soil

+ inoculation) resulted in a maximum estimated mean value of 0.76 g plant⁻¹ (Figure 2A). Seedlings cultivated in substrate with chemical fertilization showed 0.60 g plant⁻¹ (Figure 2A).

Concerning to the dry mass of roots (DMR), the estimated proportion of 35:65 (organic compost:soil + inoculation), resulted in a maximum production of 0.68 g plant⁻¹, when compared to the substrate constituted only by organic compost:soil, with 0.41 g plant⁻¹ (Figure 2B). Seedlings cultivated in substrate with chemical fertilization showed a lower value of 0.43 cm plant⁻¹ (Figure 2B), when compared to the substrate with organic compost:soil + inoculation, which resulted in an increase of 74.60% in DMR.

Regarding the total dry mass (TDM), there was an individual effect of the proportions with organic compost and inoculation ($p < 0.05$) and for proportions of organic compost without inoculation ($p < 0.01$) (Table 1). The estimated proportion of 19:81 (organic compost:soil + inoculation), rendered a higher production, with maximum TDM of 0.97 g plant⁻¹, an increment of 64.76% when compared with the substrate constituted only by organic compost:soil, with 0.70 g plant⁻¹ (Figure 2C). Plants cultivated in a substrate with chemical

Table 1 – Dry mass of the aerial portion (DMAP), dry mass of roots (DMR), total dry mass (TDM), Dickson's quality index (IQD), nitrogen content (N) of the aerial portion and C/N ratio in *Bauhinia variegata* seedlings 90 days after sowing, in response to inoculation and different proportions of organic compost.

Tabela 1 – Médias de massa seca da parte aérea (DMAP), massa seca da raiz (DMR), massa seca total (TDM), índice de qualidade de Dickson (IQD), teor de nitrogênio (N) da parte aérea e relação C/N de mudas de *Bauhinia variegata*, aos 90 dias após a semeadura, em resposta a inoculação e proporções de composto orgânico.

	DMAP	DMR	TDM	IQD	N	C/N
	(g planta ⁻¹)				%	
With Inoculation	0.64a	0.45a	0.78a	0.31a	1.84b	23.98a
Without Inoculation	0.57b	0.41b	0.70b	0.27b	1.97a	23.11b
CV%	20.37	21.62	20.05	24.94	7.37	13.35

Means followed by the same letter within the column are not statistically different by the F test.

fertilization showed a lower value of 0.74 g plant⁻¹, when compared to the results obtained with organic compost:soil (Figure 2C).

As for nitrogen content (mg), an individual effect of inoculation (Table 1) and of proportions of organic compost (Figure 3A), were observed. The estimated proportion of 62:38 (organic compost:soil), resulted in the maximum nitrogen content of 2.09 %, with an increment of 28.10%, when compared to the organic compost:soil + inoculation with 1.84 % (Figure 3A).

Chemical fertilization showed a lower value, with N content of 1.79% (Figure 3A).

Regarding to the percentage of carbon, an interaction was observed ($p < 0.05$) between the proportions of organic compost with and without inoculation. A decreasing linear effect was verified for the treatment of organic compost with inoculation and a decreasing quadratic effect for the treatment of organic compost without inoculation (Figure 3B). The estimated proportion of 11:89 (organic compost:soil), resulted in a maximum

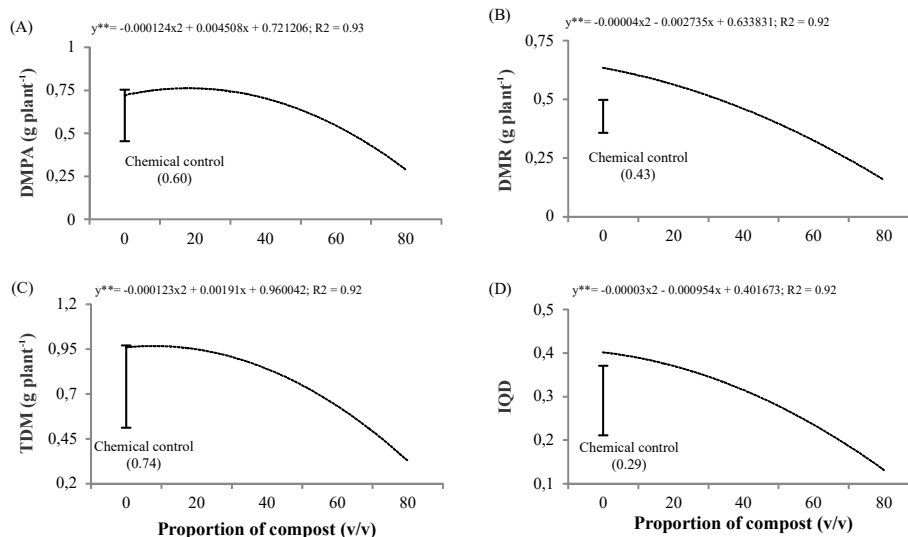


Figure 2 – Dry mass of the aerial portion (DMAP) (A); dry mass of roots (DMR) (B); total dry mass (TDM) (C) and Dickson's quality index (IQD) (D) from seedlings of *Bauhinia variegata* cultivated under different proportions of organic compost from pruned trees supplemented with cattle and goat manure and chemical fertilization, 90 days after sowing.

Figura 2 – Massa seca da parte aérea (DMAP) (A); e da raiz (DMR) (B); Massa seca total (TDM) (C) e Índice de qualidade de Dickson IQD (D) das mudas de *Bauhinia variegata* cultivadas em diferentes proporções de composto orgânico oriundo da poda de árvores acrescido de esterco bovino e caprino, com (□) ou sem inoculante (■) e adubação química aos 90 dias após a semeadura.

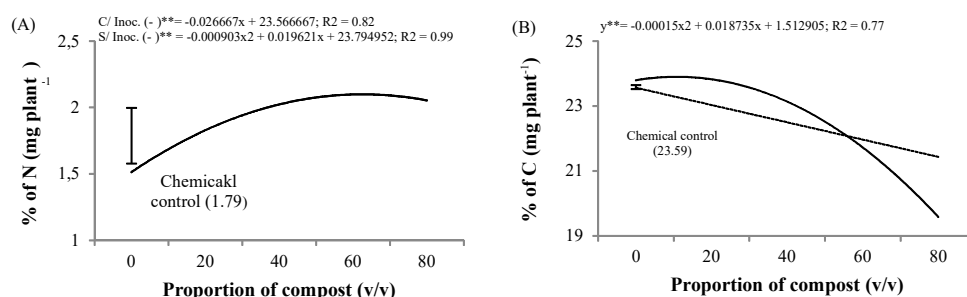


Figure 3 – Content of nitrogen (A) and content of carbon (B) of the aerial portion from *Bauhinia variegata* seedlings cultivated under different proportions of organic compost from pruned trees supplemented with cattle and goat manure, with (□) or without (■) inoculation and chemical fertilization, 90 day after sowing.

Figura 3 – Teor de nitrogênio (A) e teor de carbono (B) da parte aérea das mudas de *Bauhinia variegata* cultivadas em diferentes proporções de composto orgânico oriundo da poda de árvores acrescido de esterco bovino e caprino, com (□) ou sem inoculante (■) e adubação química aos 90 dias após a semeadura.

carbon content of 23.90%, with an increase of 17.83%, when compared to the proportion of organic compost:soil + inoculation of 23.11%.

Chemical fertilization rendered a carbon content value of 23.59%, seedlings cultivated under organic compost were more responsive to the increment of C than chemical fertilization, although there was no statistical difference ($p > 0.05$) when compared to the substrate constituted only by soil (0:100 v:v) (Figure 3B).

With respect to the C/N ratio, there was an individual effect of organic compost ($p < 0.01$), with a decreasing quadratic effect. As the addition of organic compost was increased, the C/N ratio diminished, the proportion 80:20 (organic compost:soil), resulted in a lower C/N ratio with mean value of 10.21 (Figure 4). Seedlings cultivated under substrate including chemical fertilization showed higher C/N ratio (14.57), when compared to seedlings fertilized with organic compost (Figure 4).

4. DISCUSION

Literature reports that *B. variegata* is not capable of nodulation (Sprent, 2009), in agreement with the results in the present work. It was also verified that, independently form nodulation, there was a positive effect from inoculation over seedling height, dry mass of the aerial portion and roots, total dry mass, IQD and foliar contents of N and C.

These effects may be attributed, probably not only to the capacity for biological fixation of N_2 , but also to the production of phytohormones (such as auxins, cytokinins and gibberellins) and solubilization of

phosphates and exopolisaccharides by diazotrophic bacteria (Gumiere et al., 2014; Costa et al., 2016; Silva et al., 2016; Porto et al., 2016). As registered for strains of the genus *Bradyrhizobium*, which increased the production of *Inga edulis* (Porto et al., 2017), many arboreal species are responsive to inoculation, as also the normative from the Ministry of Agriculture, Livestock and Supply (Brasil, 2011) states, for approximately 23 arboreal legume species which have authorization to be inoculated in the seedling stage. Basic research evidences that inoculation stimulates vegetal growth of various species. Works with cowpea showed results with various strains of symbiotic diazotrophic bacteria,

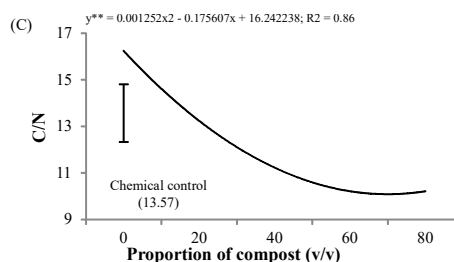


Figure 4 – Ratio of C/N in the foliar area from *Bauhinia variegata* seedlings cultivated under different proportions of organic compost from pruned trees supplemented with cattle and goat manure and chemical fertilization, 90 days after sowing.

Figura 4 – Relação C/N da área foliar das mudas de *Bauhinia variegata* cultivadas em diferentes proporções de composto orgânico oriundo da poda de árvores acrescido de esterco bovino e caprino sem inoculante (■) e adubação química aos 90 dias após a semeadura.

established or native, producing hormones, solubilizing nutrients and increasing the biological fixation of nitrogen and productivity (Guimarães et al., 2012; Costa et al., 2016).

Although the strains used in the present work are recommended for *Vigna unguiculata* L. and one strain is still under selection stage (due to its potential as inoculant), it was verified a positive stimuli for initial growth in *Bauhinia variegata* seedlings.

Therefore, there is a possibility to test mixtures of already authorized inoculants (Brasil, 2011) in non nodulating species, which may have the potential for recover degraded areas and for urban afforestation. The easy acquisition of inoculants, once they are authorized by the legislation, may reduce the research time demanded for other vegetal species. The use of organic compost:soil in association with inoculation increased the growth in height of *B. variegata* seedlings. It is essential to mention the importance of the organic compost elaborated from pruned trees and animal manure to supply organic matter and nutrients to substrates constituted by soil. This compost represents an alternative to formulate cultivation substrates, once it shows satisfactory contents of macro and micro nutrients according to the Brazilian legislation (Brasil, 2009), defined by the classification of organic fertilizer, being precisely classified as Class A. This material shows potential to increase physical properties of the soil, such as water retention and preservation of chemical characteristics of the substrate, important issues which may influence directly on foliar and radicular growth of seedlings (Delarmelina et al., 2014; Medeiros et al., 2017).

The organic compost in association to inoculation propitiated higher growth in height for *B. variegata* seedlings, when compared to chemical fertilization. Positive effects over growth in height from organic compost used in cultivation substrates for seedlings were also verified in *Gliricidia sepium* seedlings (Cavalcante et al., 2016).

It was verified that seedlings of *B. variegata* cultivated in supplemented substrates, with organic compost as well as with chemical fertilization, reached SD values above 2 mm plant⁻¹, as observed by Gomes et al. (1996). Seedlings of *B. variegata* showed higher stem diameter when cultivated in substrate constituted by soil of desertic area + cured cattle manure (1:1) (Fernandes et al., 2015). In *Sesbania virgata* seedlings,

the substrate combining sludge and vermiculite at a proportion of 60:40%, influenced growth of stem diameter (Delarmelina et al., 2014). Seedlings with higher SD tent to be more resistant to damping-off in field conditions.

Up to the value of the estimated proportion of organic compost:soil, there was an increase in the number of leaves, probably by the enhancement of the chemical and physical properties of the substrates (Figure 1C). Similar behavior occurred for *B. variegata* when cultivated in substrates based on poultry bed (Krefta et al., 2017). There was also a higher mean value (9.76 leaves⁻¹) observed in *B. forficata* seedlings when using cow urine at a concentration of 5% (Raulino et al., 2015). However, fertilization with organic compost reduced the number of leaves in *Moringa oleifera* (Medeiros et al., 2017). In *B. variegata* proportions higher than 20:80 (compost:soil) reduced the number of leaves.

The addition of organic compost to the soil propitiated a positive response in root length in *B. variegata* seedlings. This may be attributed to the improvement of the aeration ability and the reduction of density and water retention of the substrates, as a result of addition of the organic matter. Chemical fertilization did not influence the radicular length of *B. variegata* seedlings, when compared to organic compost. Although organic residues have lower contents of nutrients when compared to mineral fertilizers, they are constituted by a greater diversity of nutrients (Rodrigues et al., 2011).

B. variegata is responsive to the substrates formulated in the present work. Seedlings of this species, when cultivated in substrate constituted by cattle manure (1.27g plant⁻¹) and goat manure (0.55g plant⁻¹), also exhibited positive response 90 day after sowing (Fernandes et al., 2015). Being soil fertility an important factor for the initial growth of *B. variegata*, it is important that growth substrates may provide nutrients for the photosynthesis, generating energy needed for biomass accumulation and plant development, as registered in data showed in Figures 2 a, b, c and d.

The organic compost used to prepare the substrates showed adequate contents of Ca and P to promote an increment of dry mass of seedlings, and favorable content of organic matter, in addition to adequate C/N ratio (9) and pH (6.4). This provides higher mineralization of the organic matter for the seedlings (Brasil, 2009). Chemical fertilization did not influence the gathering

of dry mass by the seedlings, when compared to seedlings cultivated in substrates constituted by organic compost:soil. Another species within the same genus, *B. forficata*, showed increase of DMR, up to a maximum point (100%) with mean value of 12.35 g with the addition of P dosages (Ramos et al., 2000).

As responsiveness of seedlings to IQD was verified, our results show that seedlings cultivated with substrates constituted of 16:84 (organic compost:soil) have better quality. Positive effect of organic compost on IQD was also observed in seedlings of *B. variegata* cultivated in substrate prepared with poultry bed (Krefta et al., 2017) and in *E. contortisiliquum* cultivated in substrates added with organic compost:soil at a proportion of 43:57 (Sousa et al., 2016).

In the present work we verified that addition of organic compost to the substrate granted a higher content of N in the aerial portion of *B. variegata* seedlings, when compared to chemical fertilization. The content of N in the aerial portion of the seedlings may be related with a higher radicular growth and production of biomass of *B. variegata* seedlings, impelling photosynthesis and promoting a higher initial growth (Freiberger et al., 2013). Seedlings of *Enterolobium contortisiliquum* (vell.) Morong, showed higher content of N (4.2 mg g^{-1}), when cultivated in substrate constituted of 48:52 (decomposed stem of moriche palm:soil), 80 days after sowing (Sousa et al., 2013).

Seedlings of *B. variegata* showed a higher content of C in the DMAP, due to the organic compost. Seedlings of *Mimosa scabrella*, also showed higher contents of C in the biomass with values of 44.69 and 45.33% (Dallagnol et al., 2011). The low C/N ratio of leguminous species is related to the presence of soluble compounds, which contributes to mineralization and degradation efficiency, thus contributing to the N input into the soil (Ferreira et al., 2011). The analysis of the C/N ratio shows *B. variegata* has a low content of lignin and low C/N ratio, suggesting fast mineralization of the foliar portion and consequently being this an auspicious species to be used as green fertilizer. Carbon, as well as N, is a component of the organic matter which results in the improvement of the metabolism and hormonal equilibrium of plants, influencing nutrients absorption and its efficiently utilization, thus contributing to the nutritional status of the plant and its biological functioning (Dallagnol et al., 2011; Freiberger et al., 2013).

In a general way, we observed that proportions above 20:80 (organic compost:soil) promoted a reduction in the majority of variables evaluated in this work. Such phenomena results from the nutritional disequilibrium, due to the high concentration of soluble salts (B , Na^+ , Mn^{2+}) in the organic compost which may have reduced the availability of nutrients demanded in higher quantities by the plant, affecting its development. The osmotic effect from salinity affects the development of plants, once it generates nutritional disequilibrium, making water and nutrients unavailable for plant absorption (Alves et al., 2011).

The substrate prepared with organic compost from pruned trees, added with cattle and goat's manure and yellow Latosol, positively influenced the growth and nutritional status of *B. variegata* seedlings, 90 days after sowing, resulting in the production of quality seedlings in a short time period in the nursery. Although the species *B. variegata* did not show nodulation, inoculation with diazotrophic bacteria stimulated its development during the seedling stage.

5. CONCLUSIONS

Inoculation of diazotrophic bacteria increased growth in height, the height/stem diameter ratio, dry mass of roots and aerial portion, total dry mass and carbon contents total in *Bauhinia variegata* L. seedlings.

Seedlings of *Bauhinia variegata* L. cultivated under organic compost showed better development when compared with seedlings cultivated in soil and substrate with chemical fertilization.

The addition of organic compost from pruned trees, supplemented with cattle and goat's manure, to the yellow Latosol, increased contents of foliar nitrogen and carbon in *Bauhinia variegata* L.

The substrate formulated at the proportion of 16:84 (organic compost:soil + inoculation), resulted in the highest Dickson's quality index, being therefore recommended for production of *Bauhinia variegata* L. seedlings.

6. REFERENCES

Alves FAL, Silva FSL, Silveira, JAG, Pereira, VLA. Effect of external Ca^{2+} in the Na^+ and K^+ content incashew exposed to salinity. Revista Brasileira de Ciências Agrárias. 2011;6(4):602-8.

- Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Diário Oficial da União - Seção 1 Instrução normativa no 13 de 24 de março de 2011.
- Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Instrução Normativa nº 25, de 23 de julho de 2009. Anexo III 2009[Online].
- Cavalcante ACP, Silva AG, Silva MJR, Araújo RC. Seedling production of *Gliricídia* with different organic substrates. *Revista Agrarian*. 2016;9(33):233-40.
- Costa EM, Carvalho F, Nóbrega RSA, Silva JS, Moreira FMS. Bacterial strains from floodplain soils perform different plant-growth promoting processes and enhance cowpea growth. *Scientia Agrícola*. 2016;73(4):301-10.
- Dallagnol FS, Mognon F, Sanquetta CR, Corte APD. Carbon contents of five forest species and their compartments. *Floresta and Ambiente*. 2011;18(4):410-46.
- Delarmelina WM, Caldeira MVW, Faria JCT, Gonçalves EO, Rocha RLF. Different substrates for the production of *Sesbania virgata* Seedlings. *Revista Floresta e Ambiente*. 2014;21(2):224-33.
- Dickson A, Leaf AL, Hosner JF. Quality appraisal of white spruce and white pine seedling stock in nurseries. *Forest Chronicle*. 1960;36:10-13.
- Duarte DM, Nunes UR. Initial growth of *Bauhinia forficata* Link seedlings on different substrates. *Cerne*. 2012;18(2):327-34.
- Fernandes MM, Fernandes MRM, Sousa FL. Production of seedlings of three tree species for the recovery of areas in the process of desertification. *Revista Científica Eletrônica de Engenharia Florestal*, v25, n1, 2015.
- Fernandes RM, Nóbrega RSA, Fernandes MR, Souza WC, Lustosa Filho JF. Substrates and inoculation with *Bradyrhizobium* growth of tamboril (*Enterolobium contortisiliquum*) degraded área. *Revista Agrarian*. 2017;10(35):52-60.
- Ferreira DF. SISVAR: A guide for its bootstrap procedures in multiple comparisons. *Ciência e Agrotecnologia*. 2014;38:109-12.
- Ferreira EPB, Stone LF, Partell FL, Didonet AD. Productivity of common bean influenced by cover crops and soil management systems. *Revista Brasileira de Engenharia Agrícola e Ambiental*. 2011;15(7):695-701.
- Ferreira LVM, Nóbrega RSA, Silva GC, Nóbrega JCA, Moreira FMS. Growth and nodulation of *Sesbania virgata* with native and introduced strains. *Revista de Ciências Agrárias*. 2015;58(4):327-34.
- Freiberger MB, Guerrini IA, Galetti G, Fernandes DM, Corrêa JC. Initial growth and nutrition of cedar (*Cedrela fissilis* Vell.) As a function of nitrogen doses. *Revista Árvore*. 2013;37(3):385-92.
- Freire JM, Jesus EC, Rouws JRC, Faria SM, Zilli JE. Effect of substrate on the growth of *Mimosa bimucronata* seedlings inoculated with rhizobia strains. *Pesquisa Florestal Brasileira*. 2017;37(90):131-8.
- Gomes JM, Paiva HN, Couto L. Production of eucalyptus seedlings. *Informe Agropecuário*. 1996;18(185):15-22.
- Guimarães AA, Jaramillo PMD, Nóbrega RSA, Florentino LA, Silva KB, Moreira FMS. Genetic and symbiotic diversity of nitrogen-fixing bacteria isolated from agricultural soils in the Western Amazon by using cowpea as the trap plant. *Applied and Environmental Microbiology*. 2012;78(18):6726-33.
- Gumiere T, Ribeiro CM, Vasconcellos RL, Cardoso EJ. Indole-3-acetic acid producing root-associated bacteria on growth of Brazil Pine (*Araucaria angustifolia*) and *Slash Pine* (*Pinus elliottii*) Antonie Van Leeuwenhoek. 2014;105(4):663-9.
- Krefta MS, Brun EJ, Facchi SP, Santos LM, Klein DR, Krefta SC, et al. Initial development of seedlings of *Bauhinia variegata* LAND *Ceiba speciosa* (AStHil.) Ravenna under substrates based on poultry litter. *Revista Scientia Agraria Paranaensis*. 2017;16(1):99-106.
- Lacerda AM, Moreira FMS, Andrade MJB, Soares ALL. Effect of rhizobia strains on nodulation and productivity of cowpea. *Revista Ceres*. 2004;51:67-82.

Lorenzi H. Árvores brasileiras: Manual de identificação e cultivo de plantas arbóreas nativas do Brasil. 5ª. ed. Nova Odessa: Instituto Plantarum; 2008. v1.

Medeiros RLS, Cavalcante AG, Cavalcante ACP, Souza VC. Growth and quality of *Moringa oleifera* Lam seedlings in different proportions of organic compost. Revista IFES Ciência. 2017;3(1):204-216.

Nascimento JC, Lage LFO, Carmagos CRD, Amaral JC, Costa LM, Sousa AN, et al. Antioxidant determination activity by DPPH method and assay for total flavonoids in leaves extracts of *Bauhinia variegata* L. Revista Brasileira de Farmácia. 2011;92(4):327-32.

Porto DS, Farias ENC, Chaves JS, Souza BF, Medeiros RD, Zilli JE, et al. Symbiotic effectiveness of *Bradyrhizobium ingae* in promoting growth of *Inga edulis* Mart seedlings. Revista Brasileira de Ciência do Solo. 2017;41:e0160222.

Raulino WNC, Cavalcante ALG, Silva HER, Ferreira LL, Porto VCN. Seedlings behavior *Bauhinia forficata* in cow urine of doses function applied via leaf. Cadernos de Agroecologia. 2015;10(3) não paginado

Ramos MRC, Pinto JEPB, Furtini Neto AE, Davide AC. Influence of the application of Nitrogen, Phosphorus and Potassium on growth and mineral composition of *Bauhinia forficata* Link (*Bauhinia*

forficata Link) Revista Brasileira de Plantas Mediciniais. 2000;3:79-86.

Rodrigues PN, Rolim MM, Bezerra Neto E, Costa RN, Pedrosa EM, Oliveira VS. Effect of compaction and organic compost application on corn biomass and macronutrient contents in soil. Revista Brasileira de Engenharia Agrícola e Ambiental. 2011;15:788-93.

Silva FG, Santos IB, Souza AJ, Farias ARB, Diniz WPS, Kuklinsky-Sobral J, et al. Bioprospecting and plant growth-promoting bacteria tolerant to salinity associated with *Atriplex nummularia* Lin saline soils. African Journal of Microbiology Research. 2016;10(31):1203-14.

Smiderle OJ, Luz FJF. Overcoming dormancy of pata-de-vaca (*Bauhinia angulata* Vell) seeds. Revista Agroambiente On-line, 2010.4(2):80-5.

Sousa LB, Lustosa Filho JF, Amorim SPN, Nóbrega RSA, Nóbrega JCA. Regional substrates in germination, growth, and natural nodulation of *Enterolobium contortisiliquum*. Revista Brasileira de Agroecologia. 2016;1(4):345-53.

Sousa WC, Nóbrega RSA, Nóbrega JCA, Brito DRS, Moreira FMS. Nitrogen sources and *Mauritia flexuosa* decomposed stem on nodulation and growth of *Enterolobium contortisiliquum*. Revista Árvore. 2013;37(5):969-79.

Sprent JI. Legume nodulation. London: John Wiley and Sons; 2009.

ERRATA

No artigo “**GROWTH RESPONSE OF *Bauhinia Variegata* L. TO INOCULATION AND ORGANIC FERTILIZATION**”, publicado no número 1, volume 43, da Revista Árvore, onde se lê:

Caliane da Silva Braulio², Rafaela Simão Abrahão Nóbrega^{3*}, Flávia Melo Moreira⁴, Ângela Santos de Jesus Cavalcante dos Anjos⁵, Janildes de Jesus da Silva⁶ and Juan Manuel Anda Rocabado²

L e i a - s e:

Caliane da Silva Braulio^{2*}, Rafaela Simão Abrahão Nóbrega³, Flávia Melo Moreira⁴, Ângela Santos de Jesus Cavalcante dos Anjos⁵, Janildes de Jesus da Silva⁶ and Juan Manuel Anda Rocabado²

onde se lê:

NÓBREGA RSA ET AL.

L e i a - s e:

BRAULIO CS ET AL.