CRESCIMENTO INICIAL DE *Clitoria fairchildiana* EM SUBSTRATOS ORGÂNICOS

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RESUMO – Substratos orgânicos formulados a partir de adições de solo a compostos orgânicos de diferentes origens podem interferir no crescimento inicial e qualidade de mudas de espécies arbóreas. Avaliamos a interação entre tipos e proporções de compostos orgânicos (CO) na nodulação e produção de mudas de *Clitoria fairchildiana*. O experimento foi disposto em delineamento inteiramente casualizado com fatorial 2 x 5, dois tipos de CO [COP (de poda de árvore) e CLU (de lixo urbano)] e cinco proporções de composto orgânico:solo (0:100; 20:80; 40:60; 60:40; 80:20; v:v), com cinco repetições. Avaliaram-se: a nodulação natural (NN), altura da planta (H), diâmetro do caule (DC), número de folhas (NF) e comprimento da raiz (CR), massa seca da parte aérea (MSPA), massa seca de raízes (MSR), massa seca total (MST), relações entre altura sobre massa seca da parte aérea (H/MSPA), massa seca da parte aérea sobre massa seca da raiz (MSPA/MSR) e o Índice de Qualidade de Dickson (IQD). As proporções de CO influenciaram H, NF, DC, CR, MSPA, MSR, MST, H/MSPA, MSPA/MSR e IQD das mudas de *C. fairchildiana.* Houve interação entre os tipos e proporções de CO para H, MSPA, MSR, MST, H/MSPA, IQD e CR. Substratos constituídos por proporções de COP ou de CLU adicionados a Latossolo reduzem o crescimento inicial e a nodulação natural das mudas. O substrato indicado para o crescimento inicial de mudas de *C. fairchildiana* pode ser constituído apenas por Latossolo Amarelo.

Palavras chave: composição de substrato, nodulação natural, qualidade de mudas.

INITIAL GROWTH OF Clitoria fairchildiana UNDER ORGANIC SUBSTRATES

ABSTRACT – Organic substrates formulated with soils added to organic compounds of different origins can interfere with the initial growth and quality of seedlings of tree species. We evaluated the interaction between types and proportions of organic compost (OC) on nodulation and production of Clitoria fairchildiana seedlings. The experiment was performed in completely randomized design and 2 x 5 factorial, two types of OC [COP (tree pruning) and CLU (urban wastes)] and five OC proportions (100:0; 80:20; 60:40; 40:60; 20:80; v:v), with five replicates. Natural nodulation, plant height (H), stem diameter (DC), number of leaves (NF) and root length (CR), shoot dry mass (MSPA), dry mass of roots (MSR), total dry mass (MST) and the ratios of plant height/shoot dry mass (H/MSPA) and shoot dry mass/root dry mass (MSPA/MSR); and the Dickson Quality Index (IQD) were determined. Proportions of OC influenced H, NF, DC, CR, MSPA, MSR, MST, H/MSPA, MSPA/MSR and IQD in C. fairchildiana seedlings. There was significant interaction between types and proportions of OC for H, MSPA, MSR, MST, H/MSPA, IQD and CR. Substrates constituted by proportions of COP added with goat and cattle manure or CLU added to Latosol (Oxisoil) reduced initial growth and nodulation of C. fairchildiana seedlings. Addition of CLU and COP supplemented with goat and

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cattle manure to compose cultivation substrate formulated with soil reduces natural nodulation. A suitable substrate for initial growth of C. fairchildiana seedlings may consist of only yellow Latosol (Oxisoil).

Keywords: natural nodulation, seedling quality, substrate composition.

INTRODUCTION

Low carbon emission in agriculture is based in the reduction of greenhouse effect gasses, through technologies with efficiently use natural resources and species with adaptability to climatic changes, allowing the balance of food production and bioenergy, as an example. The ABC Brazilian Plan is a public policy tool which pursuits a different agricultural vision, with investments in sustainable and low cost technologies, incorporating systems capable to increase production, such as biological nitrogen fixation (FBN), no tillage system and agro-forestry systems, preserving environmental equilibrium (Veronez, 2012). This agricultural vision was developed for tropical and subtropical regions, especially for the Brazilian agricultural system (Soares and Perez, 2016).

Seedlings of native forestry species produced in nurseries are mainly intended for revegetation, reforestation and forestation, vegetal implementation in degraded areas and association with agricultural production systems, increasing the production of important crops (Sousa, 2013). Some leguminous species have potential to establish symbioses with nodulating diazotrophic bacteria, trough biological nitrogen fixation (FBN), being recommended for recovering of degraded areas and agricultural soils. The utilization of such bacteria may reduce the costs with mineral fertilizers once they promote the addition of nitrogen contents to the soil-plant system (Nogueira et al., 2012).

Clitoria fairchildiana is an arboreal legume belonging to the family Angiosperma – Fabaceae - Faboideae (Leguminosae), a rustic plant exhibiting fast growth (Lorenzi, 2008) and best known as sombreiro, palheteira, butterfly pea and Philippine pigeonwings. It is found in the states of Amazon, Pará, Maranhão and Tocantins, in the dry land pluvial Amazon forest in Brazil. Besides being used as an ornamental plant, mainly due to its low and dense canopy, it is also used in landscape composition for urban and rural forestation. *C. fairchildiana* is also used in the reconstitution of vegetation in degraded areas (Lorenzi, 2008; Coelho et al., 2018). This species has the ability to establish symbioses with diazotrophic bacteria (Coelho et al., 2018). Research performed by Souza et al. (2007), verified nodulation of this species in soils from degraded areas, evidencing its compatibility with soil native rhizobia and showing abundant natural nodulation and efficient nitrogen fixation.

Aiming the production of seedlings in small municipalities, farms and communities, the utilization of different sub-products from agricultural activities constitutes a sustainable alternative, from the economical, logistic and productive point of view (Trautenmuller et al., 2016). Different residues are recommended to produce substrates constituted by subsoil materials such as: chicken manure (Torres et al., 2011), carbonized rice husk (Saidelles et al., 2009), cured cattle manure (Oliveira et al., 2014; Gonçalves et al., 2014), decomposed stem form moriche palm (Sousa et al., 2013); bio-solid (Caldeira et al., 2012) and sewage sludge (Scheer et al., 2012), residue from the extraction of *Agave sisalana* fiber (Moreira et al., 2018).

Compost from urban wastes and tree pruning added to subsoil earth also showed positive results for production of arboreal species such as *Trema micrantha* (L.) Blumes (Nóbrega et al., 2010); *Caesalpinia pulcherrima* L. Sw. (Moreira et al., 2018); *Jatropha curcas* L. (Lima et al., 2011); *Enterolobium contortisiliquum* (Vell.) Morong (Nóbrega et al., 2008) and *Eucalyptus grandis* (Silva et al., 2014).

Studying the behavior of native legumes under the effect of organic residues is essential to guarantee the successful implementation of such species, thus, promoting seedling growth through the availability of nutrients and favorable physical conditions for root development, in addition to contribute with the increment of carbon sequestration and the reduction of environmental pollution through the usage of such residues. In view of these evidences, the objective of the present work was to evaluate the interaction effect between types and proportions of organic compost to constitute a suitable regional substrate for production and nodulation of *C. fairchildiana* seedlings.

MATERIAL AND METHODS

The experiment was performed in greenhouse ate the Federal University of Recôncavo da Bahia (UFRB), Center of Agricultural, Environmental and Biological Sciences (CCAAB), in the county of Cruz das Almas – BA, Brazil, at coordinates 39º06'26" S and 12º40'39" W, and 225 m above the sea level.

Treatments were established in completely randomized design and 2 x 5 factorial, constituted by two different organic compost [COP (tree pruning) and CLU (urban wastes)] and five proportions of soil:compost (100:0; 80:20; 60:40; 40:60; 20:80; v:v), with five replicates, in a total of 50 experimental parcels.

The soil used to establish the substrates to evaluate the initial growth of *Clitoria fairchildiana* seedlings was a dystrophic yellow Latosol (Oxisol), collected from the UFRB *Campus* in Cruz das Almas, at 0 – 0.2 m depth. CLU compost was originated from a compost pile constituted by organic residues from a restaurant and tree and garden prunes, at a 3:1 ratio (tree pruning: food residues). COP compost was originated from a compost pile from the Physical Space Planning and Infrastructure Superintendence (SIPEF) – UFRB, prepared form tree and garden pruning, cattle and goat manure at a 3:1:1 ratio. Soil and the organic compost were dried and sieved through a 4mm mesh, homogenized according to the established treatments and conditioned in 1.2 dm^{-3} polyethylene bags.

The chemical and physical characterization of organic composts (Table 1) and soil were performed in the Soil Science laboratory at Sao Paulo University – ESALQ. Soil chemical and physical characterization showed: pH (H_2O): 5.2; pH ($CaCl_2$): 4.5; P available: 11.2 mg dm^{-3}; K^+: 74 mg dm^{-3}, Ca^{2+}: 0.8 $cmol_c$ dm^{-3}; Mg^{2+}: 0.4 $cmol_c$ dm^{-3}; Al^{3+}: 0.3 $cmol_c$ dm^{-3}; H+Al: 2.6 $cmol_c$ dm^{-3}; sum of bases: 1.4 $cmol_c$ dm^{-3}; T: 4 $cmol_c$ dm^{-3}; V: 35%; m: 17.65%; OM: 14.4 g kg^{-1}; sand content: 535g kg^{-1}; silt: 281g kg^{-1}; clay: 181g kg^{-1}, humidity at -10 kPa: 0.114 m^3 m^{-3}; humidity at -33 kPa: 0.111 m^3 m^{-3}. This data were extracted from Moreira et al. (2018).

Table 1 - Chemical and physical characterization of organic compost from tree pruning (COP) and urban wastes (CLU) used to constitute the production substrate for *Clitoria fairchildiana* seedlings

Chemical attribute*	COP		CLU	
	Dry	Humid	Dry	Humid
pH (H_2O)[1]	-	7.0	-	7.4
pH ($CaCl_2$ 0,01 M)	-	6.4	-	6.7
Density (g cm^{-3})	-	1.00	-	0.74
Humidity at 60 - 65°C (%)	-	12.03	-	16.55
Humidity at 110°C (%)	-	0.69	-	2.36
Organic matter (Combustion) (%)	12.10	10.64	22.25	18.57
Organic carbon (%)	5.99	5.27	11.05	9.22
Total mineral resisue (R.M.T.) (%)	87.12	76.64	74.92	62.52
Mineral residue (R.M.) (%)	6.55	5.76	7.29	6.08
Unsolved mineral residue (R.M.I.) (%)	80.57	70.88	67.63jj	56.44
Total nitrogen (NT) (%)	0.70	0.62	2.12	1.77
Total phosphorus (P_2O_5) (%)	0.23	0.20	0.86	0.72
Total potassium (K_2O) (%)	0.25	0.22	0.32	0.27
Total calcium (Ca) (%)	0.57	0.50	1.76	1.47
Total magnesium (Mg) (%)	0.13	0.11	0.14	0.12
Total sulfur (S) (%)	0.02	0.02	0.25	0.21
C/N ratio	-	9	-	5
Copper (Cu) (mg kg^{-1})	15	13	20	17
Manganese (Mn) (mg kg^{-1})	127	112	97	81
Zinc (Zn) (mg kg^{-1})	35	31	53	44
Boron (B) (mg kg^{-1})	234	206	14	12
Sodium (Na) (mg kg^{-1})	824	725	2214	1848

[1] Values for pH ($CaCl_2$) were estimated by the equation from Novais et al. (2007) apud Souza et al. (1989): pH ($CaCl_2$) = 0.12+0.89 pH (H_2O). *Data extracted from Moreira et al. (2018).

The following variables were evaluated in seedlings 90 days after sowing: number of nodule (NN); height (H), stem diameter (DC), number of leaves (NF) and root length (CR), with the aid of a 0.05 mm precision caliper and a ruler graduated in centimeters. The aerial portion located above the soil until the terminal bud was considered to determine H. Seedlings were segmented in roots and aerial portion and dried in a forced air oven at 60°C until they showed a constant weight, before the dried mass of the aerial portion (MSPA), dried root's mass (MSR), total dried mass (MST), the ratios of height/dried mass of the aerial portion (H/MSPA), dried mass of the aerial portion/dried root's mass (MSPA/MSR) and the Dickson's Quality Index (IQD) were determiners.

The resulting data was submitted to a variance analysis and polynomial regression for the quantitative variables, as a function of the different compost and their proportions when significant, using the software SISVAR (Ferreira, 2014).

RESULTS AND DISCUSION

Organic compost and their proportions influenced ($p<0.05$) variables H, NF, DC, CR, MSPA, MSR, MST, H/MSPA, MSPA/MSR and IQD in seedlings of *Clitoria fairchildiana* (Table 2).

Table 2 - Mean values for height (H), stem diameter (DC), root length (CR), number of leaves (NF), dry mass of roots (MSR), dry mass of the aerial portion (MSPA) and Dickson quality index (IQD) in *Clitoria fairchildiana* seedlings, 90 days after sowing, as a response to different organic composts [COP (organic compost from tree pruning plus cattle and got manure) and CLU (compost from urban wastes)

Residue	Variables						
	H	CR	DC	NF	MSR	MSPA	IQD
	(cm plant^{-1})		(mm plant^{-1})	(plant^{-1})	(g plant^{-1})		
COP	15.52 a	27.09 a	4.12 a	2.16 a	0.70 a	1.06 a	0.51 a
CLU	12.88 b	14.53 b	2.96 b	1.66 b	0.44 b	0.67 b	0.31 b
CV (%)	15.57	19.58	27.68	19.31	23.48	21.16	26.70

Means followed by the same letter within the same row are not statistically different, by the test F test; **($p<0.05$); *($p<0.01$).

Interaction ($p<0.05$) was verified between types of organic compost and their proportions for variables H, MSPA, MSR, MST, H/MSPA, IQD and CR ($p<0.01$).

Substrates formulated with proportions of organic compost from tree pruning and manures had no influence on seedling growth ($p<0.01$), once the greatest growth in H (15.94 cm plant^{-1}) was observed when seedlings were cultivated in substrate containing only soil. In seedling cultivated in substrates prepared with urban wastes a reduction in H was observed (Figure 1A). Growth reduction in seedling of forestry species when adding compost and/or organic residues in cultivation substrates were previously registered in *Eucalyptus grandis* and *Eremanthus erythropappus* (Melo et al., 2014).

There are some species with responsiveness to the addition of residues to the soil until approximately 58%, such as *Schinus terebinthifolius* cultivated with proportions of organic compost from cattle manure and carbonized rice husk (Caldeira et al., 2008). To produce seedlings of *Trema micrantha* (L.) Blumes, it is recommended to use a substrate with an average proportion of 54.7% urban waste compost and 45.3% dystrophic ferric Red Latosol (Oxisol) (Nóbrega et al., 2010). Seedlings of *Enterolobium contortisiliquum* (Vell.) Morong, cultivated in substrate constituted of 80% wastes' compost and 20% of subsoil earth from dystrophic ferric Red Latosol (Oxisol) without liming, influenced plant growth positively, being the recommended substrate when aiming seedling production (Nóbrega et al., 2008). Substrates formulated with soil and 33%, 23% or 5% of organic compost from tree pruning + animal manure or urban waste compost or residues from extraction of *Agave sisalana* fiber, respectively, promoted an improvement in the quality of *Caesalpinia pulcherrima* L. Sw seedlings (Moreira et al., 2018). However, there are also non responsive species, such as *Trema micrantha* (L.) Blumes (Nóbrega et al., 2010) and *Calophyllum brasiliense* Cambèss (Artur et al., 2007).

There was an individual effect ($p<0.05$) from the different types of compost and from their proportions ($p<0.05$) on DC (Table 2). Amongst the different compost studied, the organic compost from tree pruning excelled with 4.12 mm plant^{-1}, and mean value higher than the urban wastes compost (2.96 mm plant^{-1}) (Table 2). The addition of organic compost to the cultivation substrate resulted in linear decrease of plant's DC, with seedlings cultivated in substrate constituted by soil only showed higher DC (3.96 mm plant^{-1}) (Figure 1B). The addition of organic compost at the evaluated proportions reduced the seedling diameter in 21,21% for *Clitoria fairchildiana.* For *Hancornia speciosa* Gomes, *Eugenia dysenterica* and *Dipteryx alata* Vog., the DC showed better results when seedlings were produced with substrate constituted with only soil (Sobrinho et al., 2010). Cultivation of seedling of *Hymenaea stigonocarpa* in substrates containing higher proportions of carnauba residues and cattle manure had no significant effect over DC (Lustosa Filho et al., 2015).

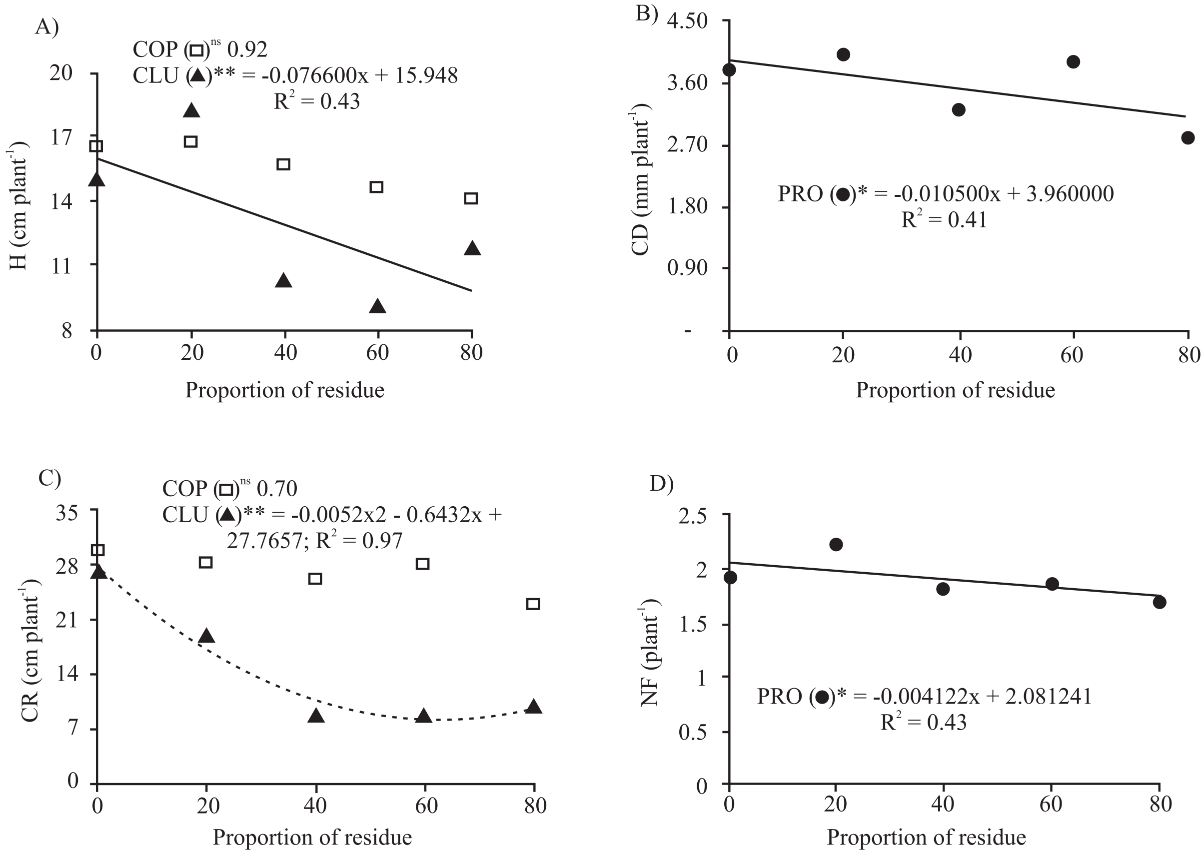

Figure 1 - A) Height; B) Stem diameter; C) Root lenght; D) Number of leavesfrom *Clitoria fairchildiana* seedlings, 90 days after sowing, cultivated in substrates constituted by different organic compost [COP (organic compost from tree and garden pruning, catttle and got manure) and CLU (compost from urban wastes)] and proportions soil:organic compost v/v (100:0; 80:20; 60:40; 40:60; 20:80).

An interaction ($p<0.01$) between the types of organic compost and their proportions (Table 2) was verified for CR. The substrate constituted only by soil promoted the maximum seedling's CR, with 27.76 cm plant^{-1}. The addition of compost from urban waste promoted a reduction in CR, while the addition of compost from tree pruning had no significant effect (Figure 1C). Seedlings of *Caesalpinia pulcherrima* L. Sw. cultivated with different residues showed a reduction in CR, showing higher mean values when cultivated in substrate constituted by soil only (Moreira et al., 2018).

Concerning the variable NF, there was an individual effect from the types of organic compost ($p<0.01$) and their proportion ($p<0.05$) (Table 2). The organic compost from tree pruning showed better results, with mean value of 2.16 leaves plant^{-1} (Table 2). Regarding to the proportions, the substrate formulated with only soil promoted the highest mean value for this variable (Figure 1D). Seedling of *Calophyllum brasiliense* Cambèss, when cultivated with the addition of manure to the substrate, had a reduction in NF. Seedlings of *Tabebuia aurea* (Manso) Benth. and Hook. f. ex S. Moore, cultivated in substrate constituted only by soil, showed higher NF when compared to other treatments, when evaluated 60 days after sowing (Botelho, 2011).

There was interaction ($p<0.05$) between the different types and proportions of organic compost on MSR (Table 2). The substrate constituted by only soil promoted the highest value of MSR with 0.87 g plant^{-1}, with a linear reduction of MSR being proportional to the addition of organic compost from tree pruning and quadratic with the addition of urban wastes compost (Figure 2A).

We verified interaction ($p<0.05$) between the types of organic compost and their proportions concerning MSPA (Table 2). Plants cultivated in substrate constituted only by soil showed maximum MSPA production with 0.99 g plant^{-1}. Concerning the compost from tree pruning there was no significant effect (Figure 2B).

When analyzing MST, it was verified interaction ($p<0.05$) between the addition of organic compost from tree pruning and compost from urban wastes. The value of MST showed a decreasing linear behavior regarding the proportions of compost added to the substrate, while a quadratic decreasing behavior when using compost from urban wastes (Figure 2C).

Production of MSR, MSPA and MST reduced with the addition of organic compost to the soil. Such behavior may indicate the species, being native from poor soils, does not respond to the addition of nutrients from organic composts or due to the soil being supplied enough contents of organic matter to fulfill the needs for seedling growth under controlled conditions. In *Eugenia dysenterica,* DC, MSPA and MSR showed superior results with substrate with only soil, differing form the other treatments. The effect of substrates on root's quality is related mainly with porosity, which affects the content of water retained and its equilibrium with aeration.

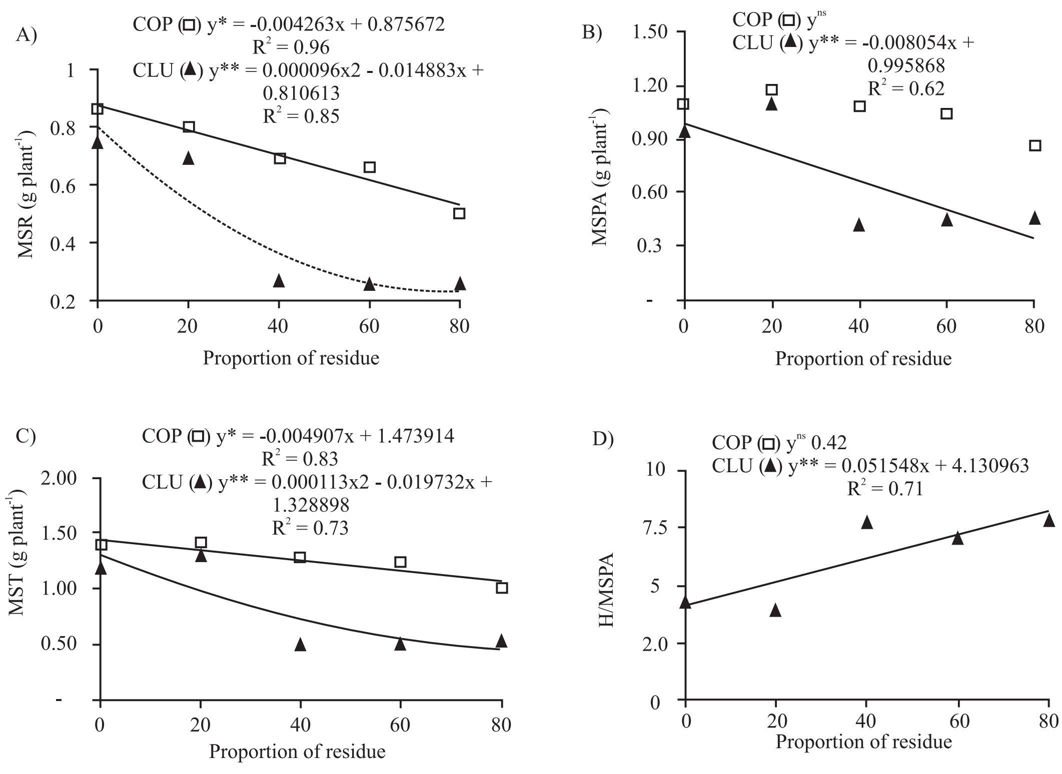

Figure 2 - A) Dry mass of roots; B) Dry mass of aerial portion; C) Total dry mass; D) Ratio height/dry mass of aerial portion from *Clitoria fairchildiana* seedling, 90 days after sowing, cultivated in substrates constituted by different types of organic compost [COP (organic compost from tree and garden pruning, cattle and got manure) and CLU (urban wastes compost)] and proportions of soil:organic compost v/v (100:0; 80:20; 60:40; 40:60; 20:80).

It was also verified interaction ($p<0.05$) in regard to the H/MSPA ratio. Urban wastes compost showed a linear increasing behavior, while the organic compost from tree pruning was non-significant (Figure 2D). In *Sesbania virgata* (Cav. Pers), an increment in such ratio was observed while incrementing the proportions of rice husk until the estimated proportion, demonstrating the negative effect of this residue in seedling's quality, showing a disproportion between the two variables, once growth was not followed by the foliar mass gain (Sousa et al., 2015). We must emphasize that while less the value of the H/MSPA ratio, more rustic will be the seedling and therefore greater will be its chance to survive in the field.

Concerning the MSPA/MSR ratio, there was individual effect between the types of organic compost and their proportions ($p<0.05$) (Table 2). A high value for this ratio may be detrimental for seedlings. Linear effect was verified for this variable, obtaining better MSPA/MSR index in plants cultivated with only soil, once they showed better mass distribution (Figure 3A). Similar results were observed by Sousa et al. (2015) in *Sesbania virgata* (Cav. Pers) cultivated in carnauba residues, which responded linearly to the addition of this compost to the substrate. It is important to analyze such ratio when seedlings are going to the field, once the mass of the aerial portion of the seedling can't be far superior to the mass of roots.

When analyzing IQD, it was observed a decreasing linear effect regarding proportions of the organic compost, with a maximum IQD of 0.61 (Table 2). Seedlings cultivated with organic compost from tree pruning in treatment 100:0 (soil:organic compost) showed the highest mean value for IQD (Figure 3B).

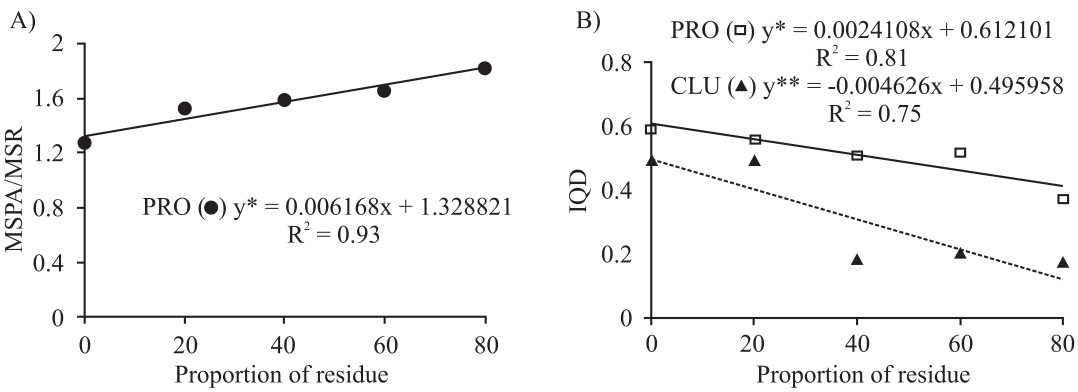

Figure 3 - A) Dry mass of the aerial portion/dry mass of roots ratio; B) Dickson's quality index of *Clitoria fairchildiana* seedlings, 90 days after sowing, cultivated in substrates constituted by different organic compost [COP (organic compost from tree and garden pruning, cattle and got manure) and CLU (urban wastes compost)] and proportions soil:organic compost v/v (100:0; 80:20; 60:40; 40:60; 20:80).

Literature reports *C. fairchildiana* as a nodulating legume, which shows abundant natural nodulation, efficiency in N_2 fixation and compatibility with populations of native rhizobia in the soil (Souza et al., 2007; Coelho et al., 2018). *C. fairchildiana* is preferentially nodulated by strains of the *Bradyrhizobium* genus (Coelho et al., 2018). Nitrogen is a nutrient with low contents in soils from degraded areas, thus limiting the development of plant species. Leguminous plants, through their capacity for fixing N_2 in a symbiotic relation, turn to be excellent colonizers for environments with low availability of nitrogen. In the present study, only the treatment with soil only (proportion 0:100 compost:soil) enabled nodulation of seedling. The addition of organic compost to the cultivation substrates inhibited nodulation, that is to say, the addition of compost inhibited the symbioses between this species and nodulating bacteria. This fact invalidates the use of organic compost to constitute cultivation substrates for this species, once is not desirable to produce seedlings without nodulation.

Native species from low fertility soils with low contents of organic matter may be not responsive to the addition of urban waste compost or tree pruning compost in the cultivation substrate, which may negatively influence its growth, as well as other variables. The results observed in the present work may have occurred once *C. farchildiana* is a plant species from the West central and Northern regions in Brazil, where Latosols (Oxisols) with low contents of organic matter and low fertility are predominant.

CONCLUSIONS

Substrates constituted by proportions of soil and organic compost from tree pruning supplemented with cattle or got manure or urban waste compost added to the Latosol (Oxisol) reduces the initial growth and natural nodulation of *Clitoria fairchildiana* seedlings.

The substrate recommended for initial growth of *Clitoria fairchildiana* seedlings may be constituted by yellow Latosol (Oxisol).

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Recebido para publicação em 17/10/2019, aprovado em 20/03/2020 e publicado em 30/04/2020.