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Conilon plant growth response to sources of organic matter

Waylson Zancanella Quartezi¹, Ramon Amaro de Sales², Talita Aparecida Pletsch¹, Sávio da Silva Berilli³, Adriel Lima Nascimento^{2*}, Leonardo Raasch Hell¹, Euzileni Mantoanelli¹, Ana Paula Candido Gabriel Berilli³, Ricardo Tobias Plotegher da Silva³ and Raniele Toso³

¹Federal Institute of Education, Science and Technology of Espírito Santo / Mountain Campus, Highway ES 130, km 01, Palhinha Neighborhood, CEP: 29890-000, Mountain, ES, Brazil.

²Federal University of Espírito Santo/ Alegre Campus. Brazil. Alto Universitário, s / n - Guararema, 29500-000, Alegre, ES, Brazil.

³Federal Institute of Education, Science and Technology of Espírito Santo / Itapina Campus, Highway BR 259, km 70, Área rural, CEP: 29700-970, Colatina, ES, Brazil.

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In the production of quality plant, it is important to consider the growing substrate since it provides plants with very important physical and chemical characteristics of the soil. Many organic materials of vegetal or animal origin have been used in mixtures of substrates for plant production. This study evaluated the development, quality and physiological components of Conilon coffee plants as a function of substrates containing organic materials of different origins. The experiment was carried out in a greenhouse, in a randomized block design with five treatments: T-Control treatment with 100% of soil and the other treatments with 85% of soil and 15% of organic matter derived from urban waste compost, mature cattle manure, dairy residue, and tannery sludge. Development, quality and physiological characteristics of plants were evaluated. All sources of organic matter favored the development of the Conilon coffee plants in relation to the plant receiving no organic matter in the substrate. Dehydrated tanning sludge in the proportion of 15% provided inferior plant performance compared with treatments with the other organic sources and a greater production of flavonoids. The treatments T-Compound, T-Dairy, and T-Manure provided better results than the other treatments for most of the evaluated characteristics, and can be recommended as components of substrates in the production of Conilon coffee plants.

Key words: *Coffea canephora*, alternate substrate, sustainability, Dickson quality index, multiplex.

INTRODUCTION

Coffee belongs to the genus *Coffea* of the family Rubiaceae. It originates from Ethiopia and is a tree or

shrub with a woody, lignified, straight and almost cylindrical stem (Silva et al., 2017). *Coffea canephora*

*Corresponding author. E-mail: waylson.quartezi@ifes.edu.br.

Pierre ex. Froehner, also called Conilon, is among the species commercially exploited in Brazil. *C. canephora* is a diploid ($2n = 22$ chromosomes) plant, self-sterile and alogamous (outcrossing) due to gametophytic self-incompatibility (Conagin and Mendes, 1961; Dalcomo et al., 2017).

Coffee production is an important activity of the Brazilian agribusiness, generating many direct or indirect jobs and accounting for most of the country's exports (Vallone et al., 2009). Coffee is one of the most important commodities in the world trade and its beverage is appreciated in many countries, being consumed by millions of people due to its organoleptic characteristics and its stimulating effect (Alves et al., 2009).

Brazil is the largest producer and exporter of coffee beans in the world, reaching a record harvest in 2016 of 56.1 million bags, with 19% represented by *C. canephora* (Porto et al., 2015; Teixeira et al., 2017). According to census data from the Brazilian Institute of Geography and Statistics (IBGE, 2017), the Conilon (*C. canephora*) coffee had in 2016 a planted area of approximately 431,104 ha, with production of 468,486 tons, with an expected increase of 11% in its production for the 2017 harvest. Dardengo et al. (2013) explained that the increase in coffee plantations is due to the territorial expansion used for planting, renewal of the coffee plantations, and adaptation to the current planting systems.

The initial formation of a coffee crop is a critical phase, and a good initial development of the plants in the field may result in more vigorous plants, with a larger stand, and the ability to express the productive potential to the maximum. According to Mendes and Guimarães (1998), the first step toward success of a coffee production is the use of high quality plants, with green and shiny leaves, thick stem, and large absorbent root system (Henrique et al., 2011).

The main factors for the production of coffee plants are related to the type of substrate, the container, and the matrix used (Silva et al., 2017). The substrate is very important for quality plants, as it is related to the structure, capacity of moisture retention, aeration, nutrition, and other characteristics (Soares et al., 2016).

Nogueira et al. (2011) pointed that there is a significant increase in research related to substrate, which is one of the main agents influencing quality of plants, and species may respond similarly or not to a specific substrate (Gonçalves et al., 2014).

Organic matter is one of the main components of substrates; it increases water and nutrient retention capacity, and reduces apparent and overall densities (Caldeira et al., 2008). Several authors report that the mixture of organic residues to the substrate has promoted improvement of the chemical, physical and biological properties, creating a suitable environment for root growth and whole plant development (Bertone et al., 2007), reducing soil use and, consequently, avoiding

risks of contamination by pests and diseases. In addition, it is important to note that the use of soil and consequently avoid risks of contamination by pests and diseases (Vallone et al., 2010a; Vallone et al., 2010b; Sales et al., 2016).

Organic matter also has the ability to change primary and secondary metabolism (Biasi et al., 2009), since it supplies different beneficial or non-beneficial chemical elements. In addition, different sources of organic matter can promote different populations of microbiots and may change plant performance. The use of organic waste of various origins in the production of seedlings may be appropriate to reduce the pollutant effect of such residues in addition to being low cost organic compost (Berilli et al., 2016).

Therefore, the objective of this work was to evaluate the development and physiology of Conilon coffee plants produced in substrates with different organic sources, aiming to obtain plants with greater prospects of success in the field.

MATERIALS AND METHODS

The study was carried out at the Federal Institute of Education, Science and Technology of Espírito Santo - Campus Itapina, located in the municipality of Colatina, in the northwestern region of Espírito Santo in Brazil ($19^{\circ}32'22''$ S, $40^{\circ}37'50''$ O and 71m altitude). The experiment was conducted in a nursery, in the period from February to November 2016, with Conilon coffee plants (*Coffea canephora*) in a randomized complete block design. Five treatments were tested according to different organic sources in the substrate composition, arranged in five replicates for each treatment, with ten experimental plots. The treatments were as follows:

T-Control: 100% soil; T-Compost: a mixture in the proportion of 85% of soil + 15% of urban waste compost; T-Manure: a mixture in the proportion of 85% soil + 15% of mature cattle manure; T-Dairy: a mixture in the proportion of 85% soil + 15% dairy residue; T-Sludge: a mixture in the proportion of 85% of soil + 15% of tannery sludge.

All treatments received 10 g of limestone and 10 g of single superphosphate (SSP) per l of substrate. The soil used for the substrate mixtures is classified as a Red Distrophic Latosol (EMBRAPA, 2013) with characteristics described in Table 1, and classification of soil attributes according to Prezotti et al. (2007). The tannery sludge was supplied by the company Capixaba Couros LTDA ME, located in the municipality of Baixo Guandu - ES, and derived from the processing of bovine leather after dehydration.

Cattle manure was obtained from the facilities of confined animals at the Ifes Itapina campus. Dairy residue was obtained from the dairy company Damare LTDA, located in the municipality of Montanha-ES, derived from the equipment cleaning processes and the factory floor from cheese, butter, whey, and ultra-high temperature processing (UHT) milk productions, with all fat removed by the effluent treatment system (ETS). The urban waste compost came from the Municipal Solid Waste Plant (SWP) in the municipality of Montanha. Table 2 shows the chemical characterization of each organic matter used in the substrates.

The sources urban compost waste and tannery sludge presented the best characteristics for macro and micronutrients, with the highest values of TOM, C, N, K, Fe and Na for the urban waste

Table 1. Chemical soil characteristics used as substrate component for plants.

pH	P	K	P rem	Ca	Mg	Al	H+Al	MO	SB	CEC	t	m	V
	--mg/dm ³ --		mg/ml		-----mmol _c /dm ³ -----			g/dm ³	----mmol _c /dm ³ ----			Percentage (%)	
5.3	4.0	52.0	20.0	11.6	9.3	0.5	14.0	1.5	22.2	36.2	22.7	2.2	61.4
-	B	B	TM	M	M	B	B	B	M	B	B	B	M

B: low; M: medium; TM: medium texture; P rem: remaining phosphorus; MO: organic matter; SB: sum of bases; t: effective cation exchange capacity; CEC: cation exchange capacity at pH 7; P: phosphorus; K: potassium; Ca: calcium; Mg: magnesium; H + Al: potential acidity; Al: aluminum; m: aluminum saturation; V%: percentage base saturation.

Table 2. Physical and chemical characteristics of the organic materials used in the substrate for plants.

Parameter	Unit	Tannery sludge	Cattle manure	Dairy residue	Urban waste compost
Moisture at 60-65°C	%	8.89	8.52	5.39	7.58
pH in CaCl ₂	-	7.65	6.78	6.96	7.30
Density	g/cm ³	0.6	0.6	0.75	0.6
TOM	%	23.72	46.33	33.17	50.52
C	%	12.98	20.19	17.31	23.08
C/N	-	7/1	10/1	9/1	9/1
N	g/dm ³	17.40	21.00	20.20	24.90
P	g/dm ³	7.21	11.93	4.54	5.63
K	g/dm ³	2.49	7.47	5.64	15.02
Ca	g/dm ³	230.20	21.80	111.10	40.70
Mg	g/dm ³	17.50	5.40	16.90	5.10
S	g/dm ³	83.30	4.50	2.00	5.20
Fe	g/dm ³	2.50	0.40	7.50	8.70
Na	g/dm ³	4.80	3.70	2.40	6.30
Zn	mg/dm ³	71.00	357.60	141.60	119.20
Cu	mg/dm ³	12.50	135.00	17.00	32.50
Mn	mg/dm ³	102.20	553.40	158.50	160.00
B	mg/dm ³	409.20	16.10	17.20	39.50
Cr	mg/dm ³	60.00	20.00	19.50	36.08

Results on dry matter basis (mass/mass); TOM: Total Organic Matter; C/N: Carbon/nitrogen ratio; C: Organic carbon; N: Nitrogen; P: Phosphorus; K: Potassium; Ca: Calcium; Mg: Magnesium; S: Sulfur; Fe: Iron; Na: Sodium; Zn: Zinc; Cu: Copper; Mn: Manganese; B: Boron; Cr: Total chromium.

compost and pH, Ca, Mg, S, B, Cr for the tannery sludge. The dairy residue presented the worst performance compared to the other sources of Organic Matter.

The plants were planted in 8 x 18 cm plastic bags manually filled with previously mixed materials in the treatment proportions, observing the compaction of the parts. The substrates were rested in the plant nursery of for 30 days before planting the cuttings. Cloning was carried out 30 days after the filling of the plastic bags, using cuttings selected from shoots of clone no. 02, Var. Conilon "VITORIA INCAPER 8142". Variety with recommendation of the planting of clones in line, high vegetative vigor, average yield of 70.40 bags benefited ha, uniform maturation, tolerance to rust and hydric stress. At the time of planting, the main stem of the shoot was cut about 3 cm below and 1 cm above the petiole. The secondary stems were cut 1 cm from the main stem, as well as 2/3 of the leaf area. All cuttings were treated by immersion in antifungal solution. Cultural treatments of plants over the experimental period were as recommended by Ferrão et al. (2012).

At 3 and 4 months after planting, foliar spraying of 20 g of urea and 20 g of potassium chloride dissolved in 10 l of water was

applied to the plants using a watering can. About 30 min after fertilization, the plants were manually irrigated, so that the excess of fertilizer retained on the leaves was washed. At the end of the experiment, 120 days after cutting preparation, the plants reached planting size and compounds were estimated with a Multiplex® fluorometer (Force-A).

The following compounds were estimated: nitrogen balance (NBI-G and NBI-R), chlorophyll (SFR-G and SFR-R), anthocyanin (ANT-RG and ANT-RB), and flavonoids (FLAV). The measurements were carried out by pointing the device to the canopy, from top to bottom, at an angle of approximately 45°. Multiplex® indices were derived from different combinations of wavelengths emitted by the device.

The following parameters were also evaluated: leaf number (LN); plant height (H), measured from the shoots at the base to the apex of the plant; stem diameter (STD), by a digital caliper; leaf area (LA); fresh and dry shoot mass (SFM, SDM); fresh and dry root mass (FRM, DRM); and total fresh and dry mass of the plant (TFM, TDM). Dry mass was obtained by incubating the material in a forced circulation oven at 72 °C for 72 hours, and then weighing on a precision analytical balance.

To assess plant quality, we evaluated the ratio between plant height and collar diameter (H/CD), ratio between shoot dry mass and roots (SDM/R), and Dickson Quality Index DQI (Dickson et al., 1960) as a function of shoot height (SH), collar diameter (CD), shoot dry mass (SDM), root dry mass (RDM), and total dry mass (TDM) using Equation 1:

$$DQI = \frac{TDM(g)}{\frac{SH(cm)}{CD(mm)} + \frac{SDM(g)}{RDM(g)}} \quad (1)$$

Analysis of variance was performed using the open source program R (R Core Team 2016) followed by the Scott-Knott's test at 1% probability.

RESULTS AND DISCUSSION

The statistical analysis of data revealed significant differences between the treatments for several characteristics evaluated. Tables 3, 4 and 5 show the means of the variables in response to the treatments with different sources of organic matter in the substrate and the treatment containing only soil with chemical fertilizer for the Conilon coffee plants, at 120 days after planting. As Table 3 shows, there was no effect of the source of organic matter on the leaf number, and the treatment without organic matter equals the other treatments, wherein all had on average 3 leaves.

Plant height is one of the main characteristics to be observed by Conilon plants and coffee growers in order to determine trade time (Berilli et al., 2014). The lowest means found for this variable were 4.05 and 4.22 cm for the treatments T-Control (without organic matter), and 4.22 cm for T-Sludge (with 15% of tannery sludge and 85% of soil, without significant differences between them). The treatment with cattle manure showed growth of 25% higher than the treatment with tannery sludge, which was the only treatment that differed from the others with organic matter.

Although all treatments showed no significant difference for leaf number (Table 3), the same did not occur for leaf area, and the treatments with urban waste compost, cattle manure, and dairy residue differed from both the treatments with tannery sludge and the treatment without organic matter. This shows that only leaf number cannot be indicative of plant vigor, because leaf size plays a relevant role in plant development, represented by the leaf area, with very important role in plant metabolism. The treatment with urban waste compost had a gain of 130% when compared with the treatment without organic matter.

Thus, it is clear that the urban waste compost provided the plants with a larger leaf area and, consequently, a greater production of photoassimilates, since leaf area is one of the main responsible for photosynthesis and can be characterized according to Silva et al. (2011), as an indicative of productivity. Other authors have reported the importance of the leaf area, including Severino et al.

(2004), who affirmed that leaf area has a very important role in plant development, and leaves are the main responsible for capturing solar energy (Table 3).

Stem diameter (Table 3) was the same in the different treatments; however, the use of organic matter can provide the plants with a small gain in this characteristic when compared with the treatment without organic source, except for the treatment with cattle manure. Nevertheless, the treatment with cattle manure resulted in 2.61 mm, which was close to the value found by Vallone et al. (2010a), who reported diameter of 2.66 mm for Arabica coffee plants at 120 days using substrate with 30% of cattle manure, showing that even using twice the organic matter, the results were close. Other authors found no differences for stem diameter in Conilon plants: Braun et al. (2007) and Silva et al. (2010) evaluated different levels of shading and containers, respectively; it is possible therefore to say that this variable is an already intrinsic characteristic of the plant, and hence, it undergoes little influence from sources of variation.

The treatment with cattle manure provided the best result for crown diameter, 119 mm (Table 3). This is probably because the plant has used its photoassimilates mainly for crown gain, since the faster the plant uses its photo assimilates for shoot development, the greater its growth. Table 4 shows the biometric analyzes of fresh and dry matter masses of the shoot and root system. The fresh and dry matter of the root system showed no significant difference among the treatments. Although there was no difference, when comparing the gain provided by the different sources of organic matter, we found that the treatment with dairy residue increased dry and fresh matter of root in more than 40% compared with the treatment without organic matter. Hermann (1964) argued that the dry matter weight of the root is one of the most important parameters to estimate the survival and initial growth of plants in the field.

We found the lowest weight for fresh mass of shoot for the treatment with tannery sludge, which was lower than dairy residue in 128%. Tannery sludge has higher chromium content than the other treatments, and large quantities of this element can be toxic to plants, causing oxidative stress and damaging cell membranes (Berilli et al., 2015). For this reason, tannery sludge showed lower performance than the other treatments, including the treatment without organic matter.

The dry matter of shoot (Table 4) followed the same pattern of the fresh matter, in which the treatments with tannery sludge and the treatment without organic matter were inferior to the others. The organic matter that most stood out for this characteristic was the urban waste compost, with 0.78 g, more than 100% higher than the treatment without organic matter. Oliveira et al. (2002) pointed out that application of urban waste compost to cultivated soils has the capacity to increase the phytoavailability of the nutrients P, K, Ca and Mg, as well as increase the pH and CEC, together with the reduction

Table 3. Morphophysiological analysis of *C. Canephora* plants grown in different sources of organic matter.

Treatment	LN	H(cm)	CRD (mm)	STD (mm)	LA (cm ²)
T-Control	3.14 ^a	4.22 ^b	83.46 ^b	2.71 ^a	41.65 ^b
T-Compost	3.14 ^a	4.61 ^a	93.50 ^b	2.76 ^a	96.41 ^a
T-Manure	3.32 ^a	5.08 ^a	119.47 ^a	2.61 ^a	95.51 ^a
T-Dairy	3.36 ^a	4.73 ^a	97.58 ^b	2.92 ^a	84.53 ^a
T-Sludge	2.99 ^a	4.05 ^b	87.36 ^b	2.99 ^a	44.45 ^b
OM	3.19	4.54	96.27	2.79	72.51
CV(%)	14.65	6.32	14.39	8.86	12.68

Means followed by different letters in the column are significantly different by the Scott-Knott's test at 1% probability level. OM: Overall mean; LN: leaf number; H: plant height; CRD: crown diameter; STD: stem diameter; LA: leaf area.

Table 4. Biometric analysis of *C. Canephora* plants grown in different sources of organic matter.

Treatment	SFM (g)	RFM (g)	SDM (g)	RDM (g)	TFM (g)	TDM (g)
T-Control	1.38 ^b	1.00 ^a	0.36 ^b	0.36 ^a	2.39 ^b	0.82 ^b
T-Compost	2.85 ^a	1.26 ^a	0.78 ^a	0.44 ^a	4.11 ^a	1.12 ^a
T-Manure	2.75 ^a	1.35 ^a	0.66 ^a	0.43 ^a	4.09 ^a	1.09 ^a
T-Dairy	2.95 ^a	1.40 ^a	0.56 ^a	0.51 ^a	4.35 ^a	1.07 ^a
T-Sludge	1.29 ^b	1.14 ^a	0.41 ^b	0.44 ^a	2.43 ^b	0.85 ^b
OM	2.24	1.23	0.55	0.44	3.47	0.99
CV(%)	20.35	21.90	18.54	16.34	18.58	12.09

Means followed by different letters in the column are significantly different by the Scott-Knott's test at 1% probability level. OM: Overall mean; SFM: shoot fresh mass; RFM: root fresh mass; SDM: shoot dry mass; RDM: root dry mass; TFM: Total fresh mass; and TDM: total dry mass.

Table 5. Analysis of quality of *C. Canephora* plants grown in different sources of organic matter.

Treatment	H/DC	SDM/R	DQI
T-Control	1.57 ^b	1.06 ^b	0.28 ^a
T-Compost	1.68 ^b	1.77 ^a	0.34 ^a
T-Manure	1.95 ^a	1.64 ^a	0.31 ^a
T-Dairy	1.64 ^b	1.11 ^b	0.39 ^a
T-Sludge	1.37 ^c	0.93 ^b	0.37 ^a
OM	1.63	1.30	0.34
CV(%)	10.60	29.00	14.55

Means followed by different letters in the column are significantly different by the Scott-Knott's test at 1% probability level. OM: Overall mean; H/CD: ratio between plant height and collar diameter; SDM/R: ratio between dry matter of shoot and roots; DQI: Dickson quality index.

in soil potential acidity (Table 4). The variables fresh matter and total dry matter had the highest values in the treatments with urban waste compost, dairy residue, and cattle manure, being superior to the treatments with tannery sludge and the treatment without organic matter.

The treatment without organic matter was inferior to the treatment with urban waste compost in more than 35% for the characteristic dry matter, thus showing the strong influence that the non-use of organic matter can cause in plants that are at the initial stage of development.

Dardengo et al. (2013) mentioned that there are in the literature different quality indices that serve as an association between plant growth parameters. However, they are commonly used in plants of forest species, and few studies have used these indices in Conilon coffee. Among them, we can highlight the ratio between plant height and collar diameter (H/CD), ratio of dry mass of shoots and roots (SDM/R), and the Dickson quality index, which is one of the best quality indicators for plants (Chaves and Paiva, 2004).

The H/CD index ranged from 1.37 to 1.95, in which the treatment with cattle manure had the best result, followed by the treatments urban waste compost, dairy residue, and treatment without organic matter. The lowest value of H/CD was found for tannery sludge, 12% lower than the treatment without organic matter and 42% lower than the best result (T-Manure). In forest species, a greater ratio between height and collar diameter reflects the accumulation of reserves, ensures greater resistance and

Table 6. Average flavonoid, anthocyanin, chlorophyll and nitrogen balance indices obtained using the Multiplex® equipment on leaves of Conilon coffee plants at 120 days, grown under different organic matter sources in the substrate.

Treatment	FLAV	SFR-G	SFR-R	NBI-G	NBI-R	ANTH-RG	ANTH-RB
T-Control	0.21 ^b	1.23 ^a	1.19 ^a	0.96 ^a	0.95 ^a	-0.05 ^a	-0.73 ^a
T-Compost	0.07 ^c	1.28 ^a	1.23 ^a	1.17 ^a	1.13 ^a	-0.02 ^a	-0.66 ^a
T-Manure	0.23 ^b	1.50 ^a	1.43 ^a	1.29 ^a	0.82 ^a	-0.11 ^b	-0.75 ^b
T-Dairy	0.18 ^b	1.53 ^a	1.42 ^a	1.45 ^a	1.26 ^a	-0.09 ^b	-0.80 ^b
T-Sludge	0.29 ^a	1.36 ^a	1.38 ^a	0.91 ^a	1.02 ^a	-0.10 ^b	-0.78 ^b
OM	0.19	1.38	1.33	1.16	1.03	-0.07	-0.74
CV(%)	27.99	11.52	12.33	22.97	22.56	25.32	9.49

Means followed by distinct letters in the column differ statistically from one another by the Scott-Knott test at the 1% level. Flavonoids (FLAV), OM and anthocyanin (ANT-RG and ANT-RB), chlorophyll (SFR-G and SFR-R) and nitrogen balance (NBI-G and NBI-R).

better fixation in the soil; but its inversion can cause the plants greater difficulties to stand erect after planting, which can cause damping (Artur et al., 2007), and the same consequences can be associated with the coffee crop.

The ratio between dry matter of shoot and roots showed the best results for cattle manure and urban waste compost, according to Table 5. However, the treatment without organic matter showed no significant difference from the treatments tannery sludge and dairy residue, showing that for this characteristic, the treatment without organic matter was satisfactory. There is a lack of studies on this ratio (SDM/R) for Conilon coffee. However, in the initial phase of development, high values of this variable could be harmful to the crop, since the root system is responsible for the absorption of water and nutrients, and to support the plants, as they will be subjected to adverse weather conditions when taken to the field (Table 5). The results for the Dickson quality index indicated that there was no difference between plants grown with and without organic matter, with results varying from 0.28 in the treatment without organic matter to 0.39 in the treatment with dairy residue. However, higher values were found for plants that used organic matter in their substrate.

Table 6 shows the physiological indices of coffee plants. The indices chlorophyll and nitrogen balance showed no significant differences, but differences were found for both secondary metabolites, flavonoids and anthocyanins. Excitation of the anthocyanins by the green (ANTH-RG) and blue (ANTH-RB) lights showed the same behavior. The highest productions of these compounds were obtained in the treatments T-Control and T-Compost (values closer to zero). According to Lopes et al. (2007), anthocyanins have functions as antioxidants, defense mechanism, and biological function.

This suggests that T-Control may have promoted an increase in the anthocyanins synthesis due to some disturbance or stress, inferring that the non-use of

organic matter promotes a greater increase of this metabolite in the plant. However, the same cannot be suggested for T-Compost since the higher values of anthocyanins were not found in the flavonoids. We may associate this result with the higher value of potassium found in organic matter of Urban waste compost (Table 2), as this nutrient is responsible for the synthesis of carbohydrates and proteins (Trevisan et al., 2006), and these plants can use carbohydrates to produce anthocyanins (Table 6).

Regarding the flavonoid index, it is apparent from Table 6 that T-Sludge provided higher production of flavonoids, and this may be associated with the higher chromium content in organic matter of Tannery sludge (Table 6), which may have caused greater stress to these plants, as also observed by Berilli et al. (2016) in Conilon coffee plants. There are several classes of flavonoids such as anthocyanins, flavans, flavones, flavonols, and isoflavonoids (Coutinho et al., 2009), then we may infer that the flavonoid index is not controlled by only the behavior of anthocyanins, which may explain why T Sludge has provided low values of anthocyanins.

The use of the organic matter is as important for plant development as is an alternative for reducing production costs. Its addition to the substrate can provide considerable gains to plants, moreover, a considerable number of organic origin materials are often discarded for their toxicity and the use of these residues in turn, may be an alternative for improving the environment conditions.

Conclusions

Conilon coffee plants produced from cuttings in substrate with 15% organic matter showed a better development performance. The use of organic matter derived from dehydrated tannery sludge induced the plants to produce a higher index of flavonoids. In the morphophysiological analysis, biometric, physiological indices and analysis of

quality of *C. Canephora* plants showed that the source of organic matter from the dehydrated tannery sludge presented the resulting minors when compared with other sources of organic matter, evidencing to cause stress and damage to the plant. The plants grown in 15% of organic matter from urban waste compost, cattle manure, and dairy residue favored the characteristics of growth, therefore this organic matter could be used as components of substrates in the production of Conilon coffee plants. The sources of cattle manure and urban waste compost, presented the best performances in the propagation of Conilon coffee plants, followed by the source of dairy residue.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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