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Nutrition and growth of the conilon coffee after application of treated wastewater

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ABSTRACT

The use of domestic wastewater in agriculture reduces the production cost due to the concentrations of nutrients for plants, besides water saving and reduction of environmental impact caused by launching in the water bodies, thus its use is becoming increasingly common in agricultural production. The objective of this study was to evaluate the nutrition and initial growth of the Conilon coffee after application of domestic wastewater. The experiment was conducted in a 13x4 split-plot design, where main plots consisted of 13 clones and four depths of irrigation in sub-plots, being three depths of treated wastewater equivalent to one third, two third and 100% of the crop water demand, and a control irrigated with supply water, in a completely randomized design with three repetitions. The results showed that application of the effluent was not sufficient to meet the nutritional needs (N, P and K) for nitrogen and potassium of the Conilon coffee, however, the increment in applied depths caused higher uptake of nitrogen and potassium resulting in best initial growth of the crop.

Key words: agriculture, fertigation, environment, sewage

Nutrição e crescimento do cafeeiro conilon após aplicação de água residuária tratada

RESUMO

O uso de água residuária doméstica na agricultura reduz os custos de produção devido à concentração de nutrientes para as plantas, além de economia de água e redução dos impactos ambientais causados pelo lançamento nas fontes de água, desta forma seu uso esta se tornando cada vez mais comum na produção agrícola. O objetivo deste estudo foi avaliar a nutrição e o crescimento inicial do café conilon, após aplicação de água residuária doméstica. O experimento foi realizado em esquema de parcelas subdivididas 13 x 4, nas parcelas os clones em 13 níveis e 4 lâminas nas subparcelas, sendo três lâminas de água residuária tratada com um terço, dois terço e 100% da demanda de água da planta e uma lâmina testemunha com água de abastecimento, em delineamento completamente casualizado com três repetições cujos resultados mostraram que a aplicação do efluente não foi suficiente para atender às necessidades nutricionais (N, P e K) do cafeeiro conilon; entretanto, o aumento das lâminas aplicadas acarretou maior absorção de nitrogênio e potássio influenciando melhor desenvolvimento inicial da cultura.

Palavras-chave: agricultura, fertirrigação, meio ambiente, esgoto

Introduction

At present, Brazil has nearly 200 million peoples, pouring approximately 8.5 million m^3 of treated sewage on the environment every day, resulting in impacts in the natural resources and society (IBGE, 2008).

According to estimates for the harvest of 2012, Brazil will harvest 50 million bags of coffee of its processed product. Confirming the results, it will be the largest crop ever produced in the country, the Espírito Santo State is the largest producer of Conilon coffee, with an estimated production of 9.355 million bags (CONAB, 2012). However the Brazilian productivity of Conilon coffee is considered low, mainly due to unfavorable environmental conditions such as drought and low soil fertility.

In this context, besides the constant increasing use of irrigation in coffee has become a reality, both in areas considered marginal in terms of water availability as well as those considered appropriate (Cortez et al., 2010), the use of treated wastewater and derivatives in the agriculture, mainly in coffee, appears to save water and fertilizer, minimizing production costs, besides preserving the quality of drinking water sources (Herpin et al. 2007; Dores-Silva et al., 2011). The macronutrients such as nitrogen, phosphorus and potassium as well as micronutrients copper, zinc, boron, and others, considered essentials for the plants are found in sewage (Sandri et al., 2007).

The research about the use of fertigation with sewage in Brazil is recent, studies of this nature are not found in the literature, and when there are results, it deals mainly about Arabic coffee. However, previous studies in the country indicated that the use of treated wastewater in agriculture appears to be feasible (Leal et al., 2009). The application of treated wastewater in soil cultivated with Arabic coffee was efficient in supplying some nutrients for plant growth such as N, P, K^+, Ca^{2+}, Mg^{2+} and S, increasing the concentration of these nutrients in soil, the sum of the bases, decreases in Al^{3+} contents and also reductions in recommended doses of fertilizers and liming, therefore, decreasing costs with fertilization (Ferreira et al., 2011).

Thus, the objective of this study was to evaluate the impact of application of treated wastewater on the nutrition and initial growth of Conilon coffee.

Material and Methods

The study was conducted in the area of the Center of Agricultural Sciences, Federal University of Espírito Santo (CCA - UFES) located in the municipality of Alegre, Espírito Santo State, Brazil, with latitude 20º45’2.3” South, longitude 41º29’17.7” West and altitude of 119 m. The experiment was conducted in greenhouse conditions. According to the international classification of Köppen, the climate is “Cwa” - tropical hot and humid, with cold and dry winter, mean annual temperature of 23.1 °C and average annual rainfall of 1.341 mm.

The pots were filled with soil collected in a layer of 0-0.20 m, being an Oxisol, and sent to the laboratory where the pH, the concentration of aluminum, available phosphorus, potassium, calcium, magnesium, iron, copper, boron, zinc, manganese, sodium and carbon were determined (Embrapa, 2009). The values of organic matter, base saturation, aluminum saturation, cation exchange capacity effective and potential and the sodium saturation index were also obtained (Table 1).

Table 1. Chemical and physical soil characteristics used in the experiment

Attribute	Values
Potential Hydrogen (pH)	6.1
Calcium ($cmol_c\,dm^{-3}$)	0.7
Magnesium ($cmol_c\,dm^{-3}$)	4.9
Phosphorus ($mg\,dm^{-3}$)	2.0
Potassium ($mg\,dm^{-3}$)	16.0
H + Al ($cmol_c\,dm^{-3}$)	2.5
Aluminum ($cmol_c\,dm^{-3}$)	0.2
Organic Matter ($dag\,dm^{-3}$)	2.9
Sodium ($mg\,dm^{-3}$)	15.0
Sodium Saturation Index (%)	1.12
Sum of Bases ($cmol_c\,dm^{-3}$)	5.7
Cation Exchange Capacity Effective ($cmol_c\,dm^{-3}$)	5.8
Cation Exchange Capacity Potential ($cmol_c\,dm^{-3}$)	8.2
Base Saturation (%)	69.4
Aluminum Saturation (%)	2.6
Iron ($mg\,dm^{-3}$)	120.0
Copper ($mg\,dm^{-3}$)	1.4
Zinc ($mg\,dm^{-3}$)	2.5
Manganese ($mg\,dm^{-3}$)	15.0
Boron ($mg\,dm^{-3}$)	0.10
Sand (%)	54.0
Silt (%)	12.0
Clay (%)	34.0
Density ($kg\,dm^{-3}$)	1.10

The soil showed low levels of calcium, phosphorus and potassium, high levels of magnesium, iron, zinc and manganese, and adequate for the other parameters (Prezotti et al. 2007).

The treated wastewater used in the experiment was collected at the domestic wastewater treatment plant localized in the municipality of Jerônimo Monteiro, Espirito Santo State, Brazil. The wastewater was collected after the secondary treatment of raw sewage, so the collection was made in an outlet pipe after all the treatment process. The collected samples were sent to the laboratory for chemical characterization (APHA, 1995), the results are presented in Table 2.

Table 2. Chemical characteristics of treated wastewater used in the experiment

Attribute	Values
Potential Hydrogen (pH)	7.62
Electrical Conductivity ($dS\,m^{-1}$)	0.51
Potassium ($mg\,L^{-1}$)	12.11
Sodium ($mg\,L^{-1}$)	9.40
Chloride ($mg\,L^{-1}$)	3.54
Iron ($mg\,L^{-1}$)	<0.01
Phosphorus total ($mg.L^{-1}$)	22.7
Nitrogen total ($mg\,L^{-1}$)	52.0
Boron ($mg\,L^{-1}$)	1.70
Calcium ($mg\,L^{-1}$)	52.10
Magnesium ($mg\,L^{-1}$)	2.40
Sulfur ($mg\,L^{-1}$)	0.07
RAS ($cmol_c\,L^{-1}$)	0.35
Biochemical oxygen demand ($mg\,L^{-1}$)	263.64
Settleable Solids ($mg\,L^{-1}$)	0.60

The wastewater showed high levels of nitrogen, calcium and phosphorus as a nutrient source for plants, also verified low levels of sodium, which is very important to avoid soil salinization.

The filling of the pots was made with air-dried, homogenized soil passed through a sieve with a mesh of 4 mm. The filling was made up to 0.20 m and all the pots received the same mass of soil.

The experiment was conducted in a 13x4 split-plot, where main plots consisted of the 13 clones (V1 to V13) and in the sub-plots the depths of wastewater in a completely randomized design with three repetitions.

The irrigations depths consisted of one control characterized by La (irrigated with supply water) and three depths of treated wastewater, depths equivalent to one third (L1), equivalent to two third (L2) and 100% wastewater according to the evapotranspiration of the crop. The depths of irrigation were determined according to the need of water of the coffee maintaining soil at field capacity (FC).

Conilon coffee seedlings were transplanted in pots with three pairs of leaves, the variety used was conilon "Vitória" (8142 Incaper - *Coffea canephora*) composed of 13 clones. The seedlings of coffee were acquired from certified nursery and were transplanted to 18 L plastic pots. An initial fertilization was done according to Prezotti et al. (2007), applying 12, 5, and 10 g of P (simple superphosphate), N (urea) and K (potassium chloride), respectively at the beginning, and did not require liming. The cultural practices as fertilization and controlling pests and diseases (red mite, caterpillar and weed) were done manually during the 110 days of the experiment.

The effluent was always collected in the morning and stored in a box of 500 L, used as a reservoir. Fertigation was started 20 days after transplanting seedlings in pots. The pots always were weighted with 100 g precision scale before irrigation, and thus the difference in weight of the pots at FC and the weight before irrigation, permitted to calculate the amount of wastewater and water to be applied in each treatment of irrigation depth (Eq. 1).

$$V = P_{FC} - P$$

where, V - volume of water (L). P_{FC} - weight of the pot at field capacity (kg). P - weight of the pot before the irrigation (kg). The application of the effluent was always performed in the morning, every two days with the help of a beaker (capacity of 1 L). The total volume of effluent applied to each repetition regarding depths L1, L2 and L3 were respectively 5, 10 and 15 L of treated wastewater, being a total volume of 1,560 L of effluent used throughout the experiment.

At the end of the experiment the nitrogen, phosphorus and potassium contents were analysed in the leaves (Embrapa, 2009). The plant growth parameters were also evaluated, thus were measured leaf area, height, total dry matter and dry matter of roots. For evaluation of plant height a ruler graduated in mm was used, where the measurement was done from the surface of the soil to the shoot apex. Leaf area was obtained for all plants, the leaves were collected from each experimental unit and sent to the laboratory for measurement using a leaf area meter. Regarding the dry matter, the plants were dried in convection forced air oven at 75 °C until there was no change in the total dry mass of the plants. For the evaluation of the roots, the soil in the pots was removed using a stream of water with the help of a sieve of 2 mm to prevent loss of the roots of smaller dimensions.

The data were tested by analysis of variance (F test) at 0.05 probability. To compare the means among the clones and irrigation depth, Scott Knott test was used at 0.05 probability. SAEG software was used to calculate the statistical analysis.

Results and Discussion

The average contents of nitrogen in the leaf and the irrigations depth x clone interaction were not significant; therefore, the main factors were analyzed separately. The Figure 1 shows the levels of leaf nitrogen in function of the clones of the conilon coffee.

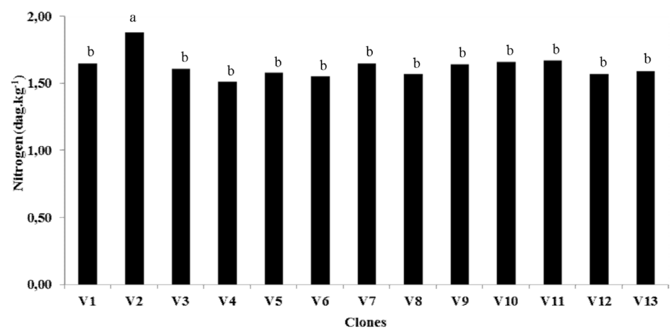

Figure 1. Mean contents of nitrogen (dag kg^{-1}) in the leaf in function of the clones of conilon coffee "Vitória 8142". Means followed by the same letter do not differ at 0.05 probability level by Scott Knott test (CV = 10.53%)

The clone V2 showed higher concentrations of nitrogen in leaf differing from the other clones which did not show significant differences between them. This result may be explained by the intrinsic capacity of each clone to absorb and to accumulate this nutrient, and that the experimental period may not have been sufficient to greater accumulation of leaf nitrogen.

The Figure 2 shows the nitrogen leaf contents in function of the depth of treated wastewater applied to the conilon coffee.

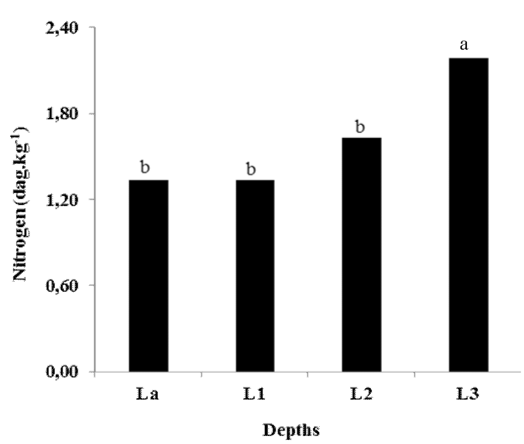

Figure 2. Mean contents of nitrogen (dag kg^{-1}) in the leaf in function of the depths of treated wastewater applied in the clones of coffee conilon "Vitória 8142". Means followed by the same letter do not differ at 0.05 probability level by Scott Knott test (CV = 10.53%).

In relation to the depths of treated wastewater applied, it was noted that depth L3 showed higher nitrogen concentration statistically than other depths. This result is related to increased volume of effluent applied in depth L3, and thus resulting in increase of nutrients in the soil and consequently absorbed by the coffee plant.

However, the application of treated wastewater was not sufficient to satisfy the need of the crop from 2.9 to 3.2 dag kg^{-1} (Prezotti et al., 2007). The coffee plant requires large amounts of nitrogen, so the treated wastewater would be responsible for reduction in the fertilization of soil, thus minimizing the cost of production. The effluent was responsible for reductions of 19% in the recommendation of nitrogen in a study in Brazil for the cultivation of coffee (Ferreira, 2008).

In a pilot study in Brazil about the soil-plant system with irrigation using domestic effluent also in coffee, a decrease was observed in leaf nitrogen concentration after two years of implementation, but the mean levels in the leaf were still enough to satisfy the need of the crop (Herpin et al. 2007).

The application of treated domestic sewage reuse increased the nitrogen concentration in an Oxisol after ten weeks of incubation (Fonseca et al., 2005). Medeiros et al. (2005) observed a higher accumulation of leaf nitrogen in coffee after 270 days of irrigation with domestic effluent, and it exceeded the treatment under mineral fertilization.

Regarding the phosphorus content in the leaf, only the factor clone was significant. The mean contents of phosphorus in the leaf in function of clones of the coffee conilon are shown in Figure 3.

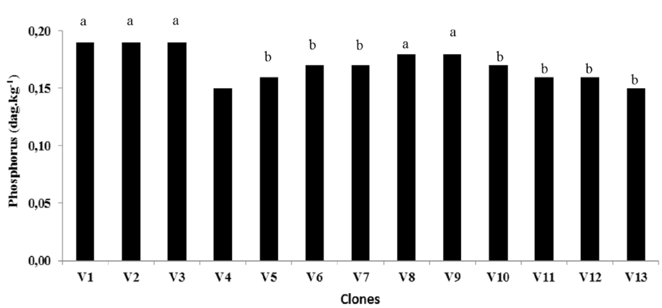

Figure 3. Mean content of phosphorus (dag kg^{-1}) in the leaf in function of clones of conilon coffee Victoria 8142. Means followed for same letter do not differ at 0.05 probability level by Scott Knott test (CV = 12.44%)

The foliar concentrations of phosphorus were considered adequate (0.12 to 0.16 dag kg^{-1}) for all clones, being V1, V2, V3, V8 and V9 showing statistically higher means. Deduce that the treated wastewater was sufficient to supply the demand of phosphorus of the plants. Similar results were found with domestic sewage in the coffee crop during the three years of cultivation using the effluent (Herpin et al., 2007). It was observed that compared with the conventional management, the irrigation with domestic sewage resulted in higher contents of phosphorus in the leaf of the coffee during the evaluations (Medeiros et al., 2005).

For the potassium content in the leaf, only the main factors were significant. The concentrations of potassium in the leaf in function of coffee conilon clones are shown in Figure 4.

The potassium concentration in a wastewater is low to satisfy the needs of coffee plant, being potassium required in large quantities by the crop. Its content in the leaf was considered inadequate under the application of treated

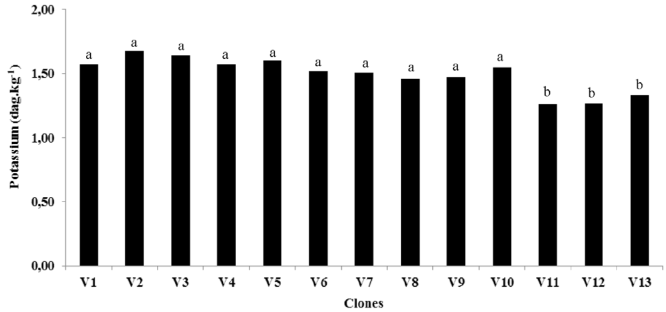

Figure 4. Mean content of potassium (dag kg^{-1}) in the leaf in function of clones of conilon coffee "Victoria 8142". Means followed for same letter do not differ at 0.05 probability level by Scott Knott test (CV = 13.77%)

wastewater, probably due to low concentration of the element in the effluent (Table 2), being required an additional fertilizer application (Prezotti et al., 2007).

The contents of potassium (dag kg^{-1}) in the leaf in function of applied depth of domestic sewage in each clone of coffee conilon are shown in Figure 5.

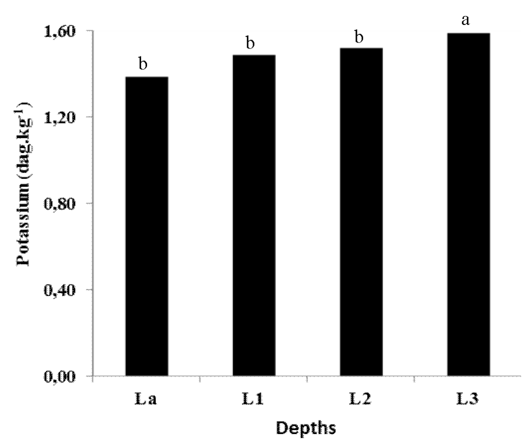

Figure 5. Mean content of potassium (dag kg^{-1}) in leaf in function of the depths of treated wastewater applied in clones of coffee conilon "Vitória 8142". Means followed for same letter do not differ at 0.05 probability level by Scott Knott test (CV = 13.77%)

Due to the increased volume of effluent applied in the depth L3 treatment, statistically higher potassium concentration in leaves were found compared to other depths.

The application of treated wastewater in coffee is not sufficient to meet the potassium demand of the crop due to low intake of the nutrient from the soil, being recommended mineral fertilizer with potassium supplement (Medeiros et al., 2005). However, Herpin et al. (2007) verified that three foliar applications of potassium in coffee plants irrigated with domestic effluent satisfied the needs of the crop. Potassium is the third most accumulated element in conilon coffee, representing 20% of the macronutrients distributed in different plant organs, being more required during the production phase, thus the coffee would need a complementation of the nutrient in soil to satisfy the demand of the crop throughout its growing cycle (Ferrão et al., 2007).

The mean values of leaf area, irrigation depth x clone interaction was significant, the mean values shown in Table 3.

For the irrigations depths within each clone, it was observed that the highest values of leaf area were obtained for L2 and

Table 3. Mean values of leaf area (cm^2) in function of the depths of treated wastewater applied in clones of conilon coffee "Vitória 8142"

Clone	Depths			
	La	L1	L2	L3
V1	1548.01 Cb	1863.94 Ca	3013.90 Ba	3809.35 Aa
V2	1170.40 Cb	1737.55 Ba	2797.81 Aa	2881.70 Ac
V3	2037.26 Ca	1987.40 Ca	3303.75 Ba	4122.63 Aa
V4	2346.96 Ca	2089.82 Ca	3210.91 Ba	4398.87 Aa
V5	1357.39 Cb	1966.36 Ba	3102.02 Aa	3489.20 Ab
V6	1898.53 Ca	1968.76 Ca	2921.77 Ba	3661.60 Ab
V7	1514.66 Cb	1840.12 Ca	3194.34 Ba	4057.13 Aa
V8	1580.68 Cb	1704.04 Ca	2891.86 Ba	3553.71 Ab
V9	1426.15 Cb	1795.47 Ca	2979.65 Ba	3595.86 Ab
V10	1255.54 Cb	2098.43 Ba	3354.48 Aa	3657.56 Ab
V11	1470.70 Cb	2060.69 Ba	3438.22 Aa	3870.96 Aa
V12	1748.09 Cb	1937.67 Ca	3084.93 Ba	4245.60 Aa
V13	2203.90 Ca	1931.34 Ca	3302.72 Ba	4039.75 Aa
CV (%)				8.95

Means followed by the same uppercase in line and lowercase letter in columns do not differ at 0.05 probability level by Scott Knott test

L3 for the greatest volume of treated wastewater applied, resulting in greater nutrient uptake by coffee plant, as observed previously in Figures 2 and 5. Nitrogen fertilization typically promotes gains in development, controlling the growth rate, size and vigor of the plant (Neves et al., 1990).

In each depth, it was noted that the clones responded differently, mainly due to the genetic variability to influence the metabolism and leaf expansion of each clone.

In literature there are few studies of treated wastewater about growth characteristics of the coffee plant, but there are several reports that show the influence of application of treated wastewater in the growth and production of other crops, in this sense found that only with fertigation using the effluent, corn yield increased by almost 150% compared to control (Azevedo et al., 2007). Similar results in the leaf area and fruit weight were observed in bean with fertigation of wastewater irrigation in comparison with water supply and mineral fertilization (Rebouças et al., 2010).

The interaction irrigations depth x clone was significant for the height of plants, the mean values of are shown in Table 4.

Table 4. Mean values of height (cm) in function of the depths of treated wastewater applied in clones of conilon coffee "Vitória 8142"

Clone	Depths			
	La	L1	L2	L3
V1	39.66 Ca	44.10 Ca	49.20 Ba	60.20 Aa
V2	34.55 Cb	42.70 Ba	46.50 Aa	49.70 Ab
V3	32.76 Cb	32.50 Cc	42.60 Bb	48.35 Ab
V4	41.30 Ca	33.50 Bc	46.50 Aa	46.86 Ac
V5	33.23 Cb	38.23 Bb	47.40 Aa	43.00 Ac
V6	35.00 Bb	34.66 Bc	43.33 Aa	42.86 Ac
V7	34.66 Bb	38.36 Bb	44.86 Aa	45.80 Ac
V8	39.16 Da	44.30 Ca	50.40 Ba	57.10 Aa
V9	35.60 Cb	43.73 Ba	46.16 Ba	50.86 Ab
V10	32.83 Cb	36.33 Bb	39.70 Bb	46.75 Ac
V11	30.66 Bb	34.10 Bc	45.30 Aa	46.50 Ac
V12	32.50 Cb	37.66 Bb	38.23 Bb	46.00 Ac
V13	33.50 Bb	33.10 Bc	36.83 Bb	49.00 Ab
CV(%)				7.87

Means followed by the same uppercase in line and lowercase letters in column by Scott Knott test do not differ at 5% probability

The highest values for height were obtained for the larger depths applied, the same way as occurred in leaf area, the largest volume of treated wastewater showed higher accumulation of nutrients for the development of the conilon coffee. Regarding the clones within each irrigation depth, there was no definite trend for the height in the different clones, as also occurred in leaf area, due to the individual capacity of each clone to respond of the applying this type of effluent.

The results can be compared in a study of different types of water quality, where the reuse of treated wastewater had the highest mean height in all species of eucalyptus studied, due to increased nutrient intake from the effluent (Rocha, 2011).

The mean values of root dry matter are shown in Table 5, the interaction irrigation depth x clone was significant.

Table 5. Mean values of root dry matter (g) in function of the depths of treated wastewater applied in clones of conilon coffee "Vitória 8142"

Clone	Depths			
	La	L1	L2	L3
V1	30.49 Cb	34.73 Ca	47.01 Bb	55.06 Ac
V2	26.82 Cb	32.57 Ba	42.27 Ab	44.65 Ad
V3	33.22 Ca	32.09 Ca	46.62 Bb	54.00 Ab
V4	38.41 Ca	35.09 Ca	47.29 Bb	62.13 Aa
V5	30.87 Cb	33.54 Ca	45.60 Bb	50.93 Ac
V6	34.46 Ca	35.99 Ca	46.23 Bb	58.17 Ab
V7	29.24 Cb	33.17 Ca	47.14 Bb	53.26 Ac
V8	31.85 Bb	34.28 Ba	50.83 Aa	54.00 Ac
V9	30.39 Cb	34.75 Ca	47.19 Bb	54.99 Ac
V10	27.62 Cb	37.22 Ba	51.68 Aa	52.64 Ac
V11	30.41 Cb	35.95 Ba	53.06 Aa	57.25 Ab
V12	32.46 Cb	35.46 Ca	46.98 Bb	62.51 Aa
V13	35.36 Ca	34.12 Ca	47.74 Bb	53.31 Ac
CV (%)				6.86

Means followed for the same uppercase in line and lowercase letters in the column do not differ at 0.05 probability level by Scott Knott test.

As occurred in the aerial parts, the depths of treated wastewater applied resulted in the higher mean dry matter of roots, and the highest irrigation depth showing significantly higher values, demonstrating the potential for reuse of the effluent in conilon coffee.

Similar results showed higher values of root dry mass and total dry matter in seedlings of *Eucaliptos grandis* and *Eucaliptos urophylla* fertigated with treated wastewater than plants irrigated with supply water and fertigated with aquaculture effluent (Lougon, 2010).

Evaluating aspects of bean growth with application of wastewater, increased concentration of the effluent in the supply water for the irrigation of plants induced increase in biomass production of root (Rebouças et al., 2010).

The mean values of total dry matter are shown in Table 6, irrigations depth x clone interaction was significant.

Statistically, treated wastewater provided the highest dry matter accumulation compared to La depth, and the higher depth of the effluent applied having the highest means, due to the increased nutrient input on the soil and consequently absorbed more than the coffee tree in relation to La depth of supply water, being the V4 clone showing the highest and significantly different total dry matter in relation to other clones. As the leaf area and root dry matter were significantly higher for the depth of wastewater applied as shown above (Table 3 and 6), it probably favored the greater capture of light and nutrients by the leaves, influencing the production of assimilates by photosynthesis and consequently a higher accumulation of dry matter by the coffee plant, showing that

Table 6. Mean values of total dry matter (g) in function of the depths of treated wastewater applied in clones of conilon coffee "Vitória 8142"

Clone	Depth			
	La	L1	L2	L3
V1	25.39 Ba	29.01 Ba	50.70 Aa	43.85 Ab
V2	21.31 Bb	27.47 Ba	27.63 Bc	39.37 Ab
V3	31.88 Ba	29.42 Ba	41.92 Ab	46.34 Ab
V4	21.95 Bb	24.99 Ba	35.73 Bc	46.42 Ab
V5	23.27 Bb	25.54 Ba	31.50 Bc	40.93 Ab
V6	25.88 Aa	28.64 Aa	31.18 Ac	43.91 Ab
V7	21.10 Bb	27.20 Ba	25.41 Bc	29.97 Ab
V8	25.87 Ba	32.90 Ba	32.57 Bc	45.95 Ab
V9	29.02 Ca	26.95 Ba	29.47 Bc	49.18 Aa
V10	16.41 Cb	23.87 Ba	26.52 Bc	43.12 Ab
V11	23.03 Cb	25.54 Ca	33.80 Bc	51.68 Aa
V12	26.76 Ba	29.82 Ba	30.30 Bc	52.94 Aa
V13	23.89 Ab	21.54 Aa	27.57 Ac	30.07 Ab
CV (%)				15.71

Means followed for the same uppercase in line and lowercase letter in the column do not differ at 0.05 probability level by Scott Knott test.

application of this type of effluent results in higher means in the initial growth of the crop. Regarding the clones within each depth, according to statistical analysis, the clones showed means without any definite trend in the depths applied.

In case of Tanzania grass, the treatments irrigated with sewage produced slightly higher dry matter in comparison to treatment irrigated with well water (Benevides, 2007).

In a study of corn fertigated with treated wastewater, it was observed that when added the effluent by irrigation with the conventional fertilization, values of total dry matter are higher than conventional fertilizer individually, due to the intrinsic nutritional value of the effluent (Fonseca et al., 2005).

Conclusions

The application of treated wastewater provided satisfactory phosphorus concentrations in the leaf of all clones of conilon coffee, while the nitrogen and potassium were not sufficient to satisfy the crop demand, requiring additional fertilizers. In addition, the L3 depth of irrigation shows the highest concentrations of nutrients in plants in relation the other depths of irrigation.

The depths of treated wastewater applied increased the mean values of the parameters of initial growth (leaf area, height, root dry matter and total dry matter) for conilon coffee, showing the potential of reuse of the effluent during the initial phase of development of the crop.

Acknowledgments

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