



Rare earth and bird cartridge compost in coffee change development

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Abstract

The use of alternative composting, such as animal carcasses, is viable for the final disposal of these wastes. Rare Earth Elements (REEs) are a homogeneous group of 17 chemical elements in the periodic table that are essential for many industries. The objective of this work was to evaluate the influence of poultry carcass compost and REEs on the development of coffee seedlings. The study was carried out at IFSULDEMINAS – Campus Muzambinho, from July 2018 to January 2019. The experimental design was a randomized complete block design (DBC) in a 3x5 factorial scheme, with four replications and 21 plants per plot central. The treatments consisted of different concentrations of poultry carcass compost (0, 150 and 300 L m⁻³) and dosages of REEs (*mix* 1, 2, 3, 4 and 5). Mixing was performed on the seedlings when they reached the second leaf pair. Evaluations were performed at 180 days after sowing, evaluated by: plant height, stem diameter, leaf number and leaf area. The data obtained were submitted to variance analysis using the *S/STAR* software, and the significant difference between treatments was determined by the F test. Detecting differences between treatments by the Scott-Knott test. It was observed that the 150 m⁻³ dosage of poultry carcass compost showed a significant increase in plant height (16.68 cm), stem diameter (3.29 cm) and leaf area (248.99 cm²). However, for the variable number of leaves, no significant difference was observed between the procedures. The use of poultry carcass compost at 150 liters m⁻³ promotes greater seedling development. The addition of REEs at the doses used does not affect the development of coffee plants.

Keywords: Cerium. *Coffea arabica*. L. Lanthanum. Organic composting.

Introduction

The production of healthy seedlings is one of the fundamental factors for the success of coffee growing, since their quality directly influences the formation of the root system and the aerial part of the plant species, and consequently, the plant behavior in the field (VALLONE, 2010). In addition to

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surviving the adverse conditions found in the field, they must develop, form vigorous plants, as they remain in the field for an average of 20 years (COGO et al., 2018). When this stage is well conducted, there is a more sustainable activity, with higher productivity and lower costs. However, there is a need to better understand the behavior of coffee seedlings both in the nursery phase and in the planting period, as this can determine the success or failure of the enterprise (BALIZA et al., 2010).

The production of coffee seedlings usually occurs through polyethylene bags and substrate consisting of 70.0 % subsoil and 30.0 % cattle manure and in addition to fertilization with chemical fertilizers, which usually have some source of phosphorus and potassium. (FREITAS et al., 2006). The choice of these components has a direct effect on the development of coffee seedlings (VALLONE et al., 2010), since these are the primary source of nutrients, water and a place of support for the plant (COGO et al., 2018).

Among the various sources of organic matter is composting that uses higher carbon/nitrogen (C:N) paly organic materials mixed with nitrogen-rich inoculants, such as animal manure. This incorporation of poor materials that occur in large quantities, but take a long time to decompose, allows for increased final fertilizer volume and nitrogen conservation of low C:N ratio materials during decomposition, which release this nutrient in ammoniacal form. At the end of composting, the composted mass is reduced by one third, because part of the organic carbon is lost as CO₂ (KIEHL, 2001). Several materials can be used in the manufacture of organic compounds, depending on their availability. Given the characteristics of organic compounds to retain nutrients and release them to the soil solution when there is their biochemical degradation, they can contribute to the reduction in mineral fertilizer splittings, thus reducing labor costs, besides ensuring greater efficiency in the fertilization of agricultural crops (PRIMO et al., 2010).

The use of agro-industrial waste for seedling production, in addition to reducing production, presents environmental advantages, utilization of waste, the disposal of which could represent a negative impact on the environment (SILVA et al., 2010). This alternative, such as sewage sludge, animal carcass and urban tree pruning as substrate components, is a viable alternative for the final disposal of these residues, in view of the economics of fertilizers and substrates that this compost can provide environmental benefits, mitigate the pollution of rivers and lakes and the reduction of soil contamination levels (TRIGUEIRO; GUERRINI, 2003). Rodrigues et al. (2012) concluded that organic compost from carcass and slaughtering of goats and sheep altered soil fertility, promoting elevation of B and S-SO₄²⁻. Manure of avian origin, compared to that of other animals, has a higher availability of nutrients, mainly nitrogen (COGO et al., 2018).

Today, much is used for phosphate fertilizers in agriculture. In the extraction of these fertilizers, comes together in its constitution elements called Rare Earths. These rare earth elements (REE) are a homogeneous group of 17 chemical elements in the periodic table that are essential for many modern industries. Also, in recent years, they have been used in agriculture. Of these elements, 15 belong to the group of lanthanides with atomic numbers between $Z = 57$ and $Z = 71$, as follows: Lanthanum (La), Cerium (Ce), Praseodymium (Pr), Neodymium (Nd), Promethium (Pm), Samarium (Sm), Europium (I), Gadolinium (Gd), Terbium (Tb), Dysprosium (Dy), Holmium (Ho), Erbium (Er), Thulium (Tm), Ytterbium (Yb) and Lutetium (Lu) (IUPAC, 2005). According to CHANG (1991), some research papers have evaluated the effects of REEs on soil attributes and plant growth. The application of these elements was related to increases in calcium and manganese bioavailability in the soil (RAMOS et al., 2016).

Much information is already available on the physiological effects of REEs on plants, particularly on membrane stability, oxidative stress, hormonal balance, enzyme production and activity, amino acid production, increased chlorophyll content and photosynthetic rate, nutrient uptake, increased tolerance to biotic and abiotic stresses, as well as synergistic and antagonistic effects on the absorption of nutrients such as N, K and P, even in the presence of low concentrations (SHYAM; AERY, 2012).

In this context, the present work aimed to evaluate the influence of bird carcass compost and rare earth elements on coffee seedling development.

Material and methods

The present work was developed in the Nursery Sector nursery of the Federal Institute of Education, Science and Technology of Southern Minas Gerais, Brazil – Campus Muzambinho, from July 2018 to January 2019.

The seedlings were produced in high cover nursery under 50.0 % shade. The experimental design was a randomized complete block design (DBC), in a 3 x 5 factorial scheme, with four replications and 21 plants per plot. The treatments consisted of different concentrations of poultry carcass compost and rare earth element (REEs) dosages. The plant material used in the experiment were certified seeds of *Coffea arabica* L. cv Catuaí Vermelho IAC-144.

The poultry carcass composting used in this experiment was developed at the Federal Institute of Education, Science and Technology of Southern Minas Gerais – Campus Muzambinho, in the poultry sector and its chemical analysis in liters is presented in Table 1.

Table 1 – Result of chemical analysis of organic compost from poultry carcass and coffee straw. Muzambinho/MG, 2019.

Parameter	Unit of measurement	Result
pH	-	6.8
Moisture	%	32.94
Organic Carbon	%	28.72
relationship C:N	-	10.64
Nitrogen	%	2.7
P ₂ O ₅	%	2.6
K ₂ O	%	1.63
Ca	g kg ⁻¹	27.5
Mg	g kg ⁻¹	6.7
S	g kg ⁻¹	9.6
Cu	mg g ⁻¹	54
Fe	mg g ⁻¹	11898
Mn	mg g ⁻¹	340
Zn	mg g ⁻¹	368
B	mg g ⁻¹	90

Source: Elaborated by the authors (2020).

The treatments consisted of three concentrations of poultry carcass compost (0, 150 and 300 liters m⁻³ of substrate). To the substrate mixture was added 5.0 kg single superphosphate and 0.5 kg potassium chloride. Completing the remainder with weed seed-free soil to a volume of 1000.0 L of substrate per *mix*.

To prepare the *mix*, containers of polyethylene bags with a volume of 260.0 cm³ were used. The bags were filled with the substrate of each plot and enchanted in beds of 1.20 m wide, with irrigation being carried out to fully moisten the substrate before sowing.

Sowing was performed with the substrate at field capacity, with two seeds in each polyethylene bag, a thin layer of weed-free soil sieved under the coffee seeds, and covered with burlap sack to date of emergence, emergence of seedlings in the substrates. Two irrigations were carried out daily through micro sprinklers within the nursery area, according to the need of seedlings. When the seedlings reached the toothpick stage of phosphorus was thinned leaving only one plant per tube, keeping them under shade (50.0 % of passage of light), and irrigated daily using micro sprinklers, with nominal flow of 60.0 L h⁻¹ as well as Almeida et al. (2011).

In the study, five doses were used, forming a *mix* of Lanthanum and Cerium according to the REEs (Table 2).

Table 2 – Lanthanum and Cerium Concentrations, Muzambinho/MG, 2019.

<i>Mix</i>	REEs (mg L ⁻¹)	
	Lanthanum	Cerium
1	0	0.0
2	100	0.2
3	200	0.3
4	400	0.4
5	600	0.5

Source: Elaborated by the authors (2020).

The *mix* was applied by irrigating the seedlings when they reached the second pair of true leaf, with a 1 L syrup per plot. The doses used were based on the experiment by Santini et al. (2019).

The evaluations were performed at 180 days after sowing, when the plants presented 4 to 6 pairs of true leaves, evaluated by the following characteristics: Height of plant, measurement of plant neck to apical bud in centimeters; stem diameter, measured on the neck of the plant with a digital caliper in millimeters; number of true sheets, direct count of the number of sheets and leaf area, measured by the CI-202 leaf area meter.

The data were submitted to analysis of variance using the statistical software *SISVAR* (FERREIRA, 2011). The significant difference between treatments was determined by the F test, Knott at 5% probability.

Results and discussion

Data on the use of different substrate doses of poultry carcass compost and addition of Lanthanum and Cerium *mix* via irrigation are presented in Table 3.

Table 3 – Number of leaves. plant height. stem diameter. leaf area at different concentrations of poultry carcass compost and Lanthanum and Cerium *mix*. Muzambinho/MG, 2019.

Mix	Compost (L)					
	0	150	300	0	150	300
	number of leaf			plant height (cm)		
1	12.5 Aa	9.24 Aa	8.75 Aa	10.66 Aa	16.68 Bb	13.87 Bb
2	9.1 Aa	8.54 Aa	10.02 Aa	13.53 Bb	8.19 Aa	16.08 Bb
3	9.5 Aa	7.9 Aa	5.5 Aa	16.47 Cb	11.66 Ba	6.59 Aa
4	27.1 Bb	10.3 Aa	9.2 Aa	8.45 Aa	15.25 Bb	13.22 Bb
5	8.62 Aa	9.01 Aa	9.7 Aa	13.52 Bb	8.8 Aa	16.68 Bb
CV(%)	98.95			18.72		

Mix	Compost (L)					
	0	150	300	0	150	300
	stem diameter			leaf area (cm ²)		
1	2.22 Aa	3.29 Bb	2.8 Bb	102.03 Aa	248.99 Bc	202.38 Bb
2	2.90 Bb	2.28 Aa	3.15 Bb	124.64 Aa	79.08 Aa	211.44 Bb
3	3.02 Ab	2.6 Ba	1.81 Ba	212.59 Bb	169.31 Bb	60.29 Aa
4	2.32 Aa	3.17 Bb	3.01 Bb	100.26 Aa	211.82 Bc	184.39 Bb
5	2.81 Ab	2.42 Aa	3.13 Ab	183.69 Bb	113.43 Aa	226.74 Bb
CV(%)	15.85			25.41		

(*) Averages followed by the same uppercase letter in the row and lowercase in the column did not differ from each other by the Scott Knott Test at the 0.05 level of significance.

Source: Elaborated by the authors (2020).

There was no interaction between treatments. According to the variance analysis, it was observed that the 150.0 m⁻³ dosage of poultry carcass compost showed a significant increase in plant height (16.68 cm), stem diameter (3.29 cm) and leaf area (248.99 cm²). Followed by dosing of 150.0 m⁻³ poultry carcass compound with dose 4 of the *mix* (400 mg L⁻¹ Lanthanum and 0.4 mg L⁻¹) with plant height (15.25 cm), stem diameter (3.17 cm) and leaf area (211.82 cm²). These results lead us to believe that attention should be given to the use of poultry manure as it proves to be an efficient source of nutrients for plants in other studies, as suggested by Cogo et al. (2011).

Higher values when compared to the treatment that had no additional poultry carcass compost and *mix* watering (dose 1), as observed in Table 3. However, for the variable number of leaves no significant difference was observed between treatments.

The results obtained in the present experiment when compared to the work of Pereira and Pinto (2013) converge to the same line, that the addition of poultry carcass compost in some proportion is beneficial for the development of seedlings providing nutrients. Likewise Dias, Melo and Silveira (2009), observed that the addition of alternative substrate to artificial substrate in coffee tree seedlings favored its development. In this sense, the results showed that the alternative organic materials used in the doses of this study, presented potential as organic matter to compose the substrate according to results found by Cogo et al. (2018). This, in turn, will contribute to the physical, chemical and biological characteristics of the substrate that will serve as a support and source of nutrients for the coffee plant, in order to create an adequate environment for the development of the roots and the plant as a whole. In addition, the substrate will accompany the seedling to the field and will be the main source of nutrient for the new side roots (GOMES E PAIVA, 2006).

This result confirms the possibility of using alternative organic materials for the production of coffee seedlings, demonstrating that the seedlings produced under the tested doses are able to survive the adverse conditions found in the field (VALLONE et al., 2010).

The use of rare earth elements such as Lanthanum and Cerium used in this work diverged with the results of Hong et al. (2003); Hu et al. (2002); Liu; Wang; Chen. (2012). that when used at certain concentrations in agriculture, can influence plant growth and development, as well as increase their resilience against stress produced by environmental factors, as well as found a positive increase in the responses of growing and yielding plants, generally with the application of REEs.

Furthermore, the choice of these components has a direct effect on the development of coffee seedlings (VALLONE et al., 2010), since this is the primary source of nutrients, water and a place of support for the plant (COGO et al., 2018). It is notable that the possibility of using more than one source of waste to fertilize the substrate is a relevant increase for coffee seedling producers.

Conclusions

The use of poultry carcass compost at 150.0 L m⁻³ promotes greater growth and development of coffee seedlings.

The use of rare earth elements in coffee is still new, having no studies on, nor reference. The addition of rare earth elements such as Lanthanum and Cerium at the doses used in the present work does not interfere with the initial development of coffee plants, having no interaction with the use of chicken carcass compound.

Elementos terra rara e composto de carcaça de aves no desenvolvimento de mudas de cafeeiro

Resumo

O uso de compostagens alternativas, como a carcaça de animais, é viável para a disposição final desses resíduos. Os elementos terras raras (ETRs) são um grupo homogêneo de 17 elementos químicos na tabela periódica que são essenciais para muitas indústrias. O trabalho teve como objetivo avaliar a influência do composto de carcaça de aves e os ETRs no desenvolvimento de mudas de cafeeiro. O trabalho foi realizado no IFSULDEMINAS – Campus Muzambinho, no período de julho de 2018 a janeiro de 2019. O delineamento experimental foi em blocos casualizados (DBC), em esquema fatorial 3 x 5, com 4 repetições e 21 plantas por parcela, considerando úteis as 5 centrais. Os tratamentos constaram de diferentes concentrações de composto de carcaça de aves (0, 150 e 300 L m⁻³) e dosagens de ETRs (mix 1, 2 3 4 e 5). A aplicação do mix foi realizada sobre as mudas quando atingiram o segundo par de folha. As avaliações foram realizadas aos 180 dias após a semeadura, avaliadas por meio da altura da planta, do diâmetro do caule, do número de folhas e da área foliar. Os dados obtidos foram submetidos à análise de variância com o emprego do Software SISVAR, sendo a diferença significativa entre tratamentos, determinada pelo Teste F, detectando as diferenças entre os tratamentos pelo Teste de Scott-Knott. A utilização de composto de carcaça de aves na dosagem de 150 litros m⁻³ promove maior desenvolvimento das mudas. A adição de ETRs nas doses utilizadas não interfere no desenvolvimento de plantas de cafeeiro.

Palavras-chave: Cério. Coffea arabica L. Compostagem orgânica. Lantânio.

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