COMPOSTING OF COFFEE HUSK AND CATTLE MANURE

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Recebido em 19.03.2012 e aceito em 27.06.2012

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ABSTRACT: The use of organic compost in agriculture is a practice that brings many advantages, avoiding environmental contamination and nutrients immobilization, besides being a source of organic matter in soil. Thus, this study addresses the production of organic compost through the association of wastes in different intervals of tilling. These practices are undertaken to better understand the influence that these procedures, association of waste and different tilling intervals, have on the final product and its influence on the cultivation of sorghum (*Sorghum bicolor*). The experiments were conducted on the Universidade Federal de Lavras' campus, one in field and another in greenhouse. Two different mixtures of residues for compost were made, only coffee husk and coffee husk associated with cattle manure, wich suffered four different tillage intervals and after obtained the compost they were tested in agricultural crop. Larger tilling intervals reduce nitrogen loss and decrease the need of labor. Organic composts obtained with shorter tilling intervals present a lower electrolytic conductivity. The addition of manure to the coffee husk provides a decrease in the C / N ratio. Composts from the mix of coffee husk and manure provide better results for fresh and dry biomass.

Index terms: Tilling intervals, confinement systems, C/N ratio

COMPOSTAGEM DE CASCA DE CAFÉ E ESTERCO DE BOVINOS

ABSTRACT: A utilização de composto orgânico em solos agrícolas é prática que traz muitas vantagens, evitando a contaminação ambiental e imobilização de nutrientes, além de ser fonte de matéria orgânica ao solo. Dessa forma, este estudo aborda a produção de composto orgânico por meio da associação de resíduos sob diferentes intervalos de revolvimento. Práticas essas realizadas para melhor entendimento da influência que estes procedimentos, associação de resíduos e diferentes intervalos de revolvimento, têm sobre o produto final e sua influência no cultivo do sorgo (*Sorghum bicolor*). Os experimentos foram conduzidos no campus da Universidade Federal de Lavras/MG sendo um em campo e outro em casa de vegetação. Foram feitas dois diferentes misturas de resíduos para compostagem, apenas casca de café e casca de café associada ao esterco de bovinos, que sofreram quatro diferentes intervalos de revolvimento e após a obtenção do composto, os mesmos foram testados em cultivo agrícola. Intervalos de revolvimento maiores reduzem a perda de nitrogênio e diminuem a necessidade de mão-de-obra. Compostos orgânicos obtidos com intervalos de revolvimento menores apresentam uma condutividade eletrolítica mais baixa. A adição de esterco na casca de café propicia redução na relação C/N. Compostos provenientes da mistura de casca de café com esterco propiciam melhores resultados de biomassa fresca e seca.

Termos para indexação: Intervalos de revolvimento, sistemas de confinamento, relação C/N

INTRODUCTION

The use of organic compost, in agricultural soils, is a practice that brings benefits to avoid the risk of environmental contamination and immobilization of nutrients, besides being a source of organic matter that acts as a soil conditioner. The composting process works in the stabilization of raw materials, chemically stabilized, resulting in dark colored composts with mineralized organic substances, and presenting nutrients that are available to plants (Silva, 2008). An important factor for the safe use of compost is its degree of maturity, resulting in stable organic matter content and absence of phytotoxic components and pathogens of plants and animals (Bernal et al., 1998). This result is achieved when some cares are taken during the processes relative to humidity, temperature, aeration, particle size, dimensions and shape of the windrow, humidity ratio x aeration x temperature and carbon / nitrogen ratio (C / N). Besides these factors, Kiehl (1985) states that the time needed to promote composting of organic wastes also depends on the number and frequency of tilling.

Waste for organic compost production

In agricultural areas there is wide availability and waste generation to obtain organic compost, from plant wastes like sawdust, sugar-cane bagasse and straw to animal wastes and the several types of manure (poultry, cattle, swine and horses). According to Carvalho and Tella (1997), the materials for the production of compost may be: energetic - crop residues; nutritious – vegetable pomace, vegetable leftovers and animal waste; and / or inoculants - animal manures in general. Fialho et al. (2005) affirm that this association can serve as a source of nutrients for the compost, benefiting the microorganisms in the windrow and thus enriching the final product. Therefore, the association of waste that gathers these characteristics is interesting and beneficial to the composting process.

Cattle manure

The cattle manure is a valuable source of nutrients and organic matter to soil, since it contains macro and micro nutrients necessary for plant growth and is a low cost alternative to mineral fertilizers. However, the high production of this waste, especially in confinement systems, has resulted in improper practices, as soil application at inadequate times and indiscriminate use. These practices may cause several environmental problems, including being the source of potentially toxic metals, inorganic salts and pathogens, nutrient losses through leaching and erosion, for having a slow release of nutrients, not coinciding with the time of absorption and plant requirements, and emission of toxic gases (Hutchison et al., 2005).

According to Lazcano et al. (2008), waste from animals may pose harm to health and environment similar to sewage residues and should be treated appropriately to stabilize the material. The stabilization involves the decomposition of the waste until the substances that pose risks are eliminated. Treatment will reflect on many of the characteristics of the waste and this will be turned into organic compost. Among the many characteristics that are altered in this process it is highlighted: a decrease in biological activity and the concentration of labile compounds (Benito et al., 2003); decrease in electrolyte leakage, reducing risks of phytotoxicity in crops, and decrease in C / N ration during the process (Lazcano et al., 2008).

Coffee husk

Minas Gerais is the Brazilian state that has the biggest coffee production, especially in the South region. In 2009 about 24 million bags of 60 kg were produced, while the state of Espírito Santo, the country's second largest producer, produced about 12 million bags (Companhia Nacional de Abastecimento, CONAB, 2010). According to Venturim (2002), the production proportion of coffee beans and husk is 1:1, which generates large production of waste. The author stresses that the use of waste / byproduct is still small, most of which is overlooked, probably due to lack of knowledge on the best use for it. However, their characteristics show that this byproduct is an excellent source of organic matter, presenting the following average values of nutrients: N - 1.7%, P - 1.0 g kg^{-1}, K - 32 g kg^{-1} and Ca - 4.0 g kg^{-1} (Costa et al., 2003). Therefore, it is evident that proper use of coffee husk, which is largely ignored or used directly in the soil, leading to processes of nutrients immobilization, is very important to the region where the study was conducted, the southern region of the state of Minas Gerais.

Tilling intervals

According to Pereira Neto (1996), in the aerobic composting the windrow oxygenation, through tilling, has the basic purpose to meet the demand of oxygen required by microorganisms, controlling the temperature and humidity of the compost pile, besides mixing the material to be composted. Brito et al. (2008) and Guardia et al. (2008) stress that the tilling influences on the aeration of the pile and in the N dynamics in the mass of the compost, an element of great importance in the composting process, being directly related to microbial activity. Therefore, to better understand the influence that tilling brings to the compost may be a way to improve the practices of the composting process.

Thus, this study addresses the production of coffee husk compost associated or not to cattle manure under several tilling intervals during the composting process, seeking the best option to use these wastes.

MATERIALS AND METHODS

Experiments

Two experiments were conducted, one on field and another in a greenhouse at the Departamento de Agricultura (Agriculture Department), in the Universidade Federal de Lavras (UFLA), Lavras, MG, Brazil, in the geographical coordinates: latitude 21°14'S, longitude 45°00'W and altitude of 918m. The climate according to Köppen climate classification is Cwa, rainy temperate (mesothermal), with dry winter and rainy summer, subtropical (Dantas et al., 2007).

The field experiment was set up in order to test the composting of coffee husk mixed or not with cattle manure at different intervals of tilling and the greenhouse experiment was to observe the performance of the obtained composts in the sorghum cropping. The chemical characteristics of coffee husk and cattle manure are found on Table 1.

Field experiment

The field experiment was conducted in a completely randomized design (CRD) with three replications (Table 2).

The experiment lasted 105 days in the period from January to April 2009. The characteristics of temperature and rainfall are in Figure 1. These data were provided by the Setor de Agrometeorologia do Departamento de Engenharia (Sector of Agrometeorology from the Department of Engineering), Universidade Federal de Lavras (UFLA).

Table 1. Chemical characteristics of utilized wastes.

Waste	B	Zn	Ca	P-Total	K-Total	N-Total	C-Total	C/N ratio
	mg kg^{-1}		----- g kg^{-1}-----			----%----		
Coffee Husk	13.5	67	4.24	1.3	21.2	1.8	45	25:1
Cattle Manure	11.0	181	10.7	5.0	7.6	1.9	30	16:1

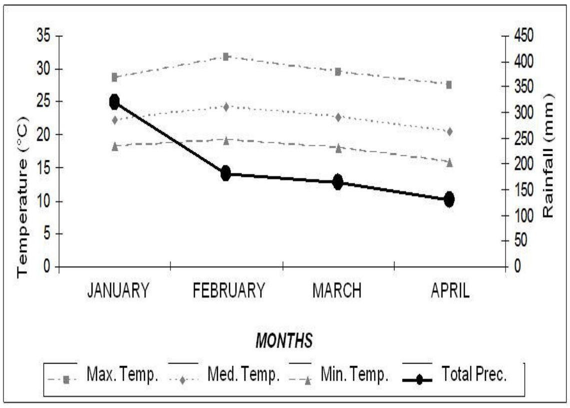

Figure 1. Climatic diagram (temperature and rainfall) in the period when the experiment in field was being conduced.

Coffee husk used came from a coffee processing unit located in UFLA and the coffee that supplied this type of husk was arabic. The cattle manure was obtained in a confinement system located in the Departamento de Zootecnia (Department of Animal Husbandry), UFLA.

The windrows were built in the composting area in the open and in direct contact with soil, with an initial volume of 1m^3. To obtain this volume a wooden frame with 1x1x1m dimensions was used (Figure 2). In the treatments where cattle manure was used the ratio was 1:4 (1 part manure to 4 parts coffee husk), as recommended by Rashid et al. (2001).

During the experimental period humidity, temperature, pH and electrolytic conductivity was monitored.

Table 2. Treatments (field experiment) mixed with organic material used for composting and treatments (vase experiment).

Treatments	Abreviation
Composting experiment (field):	
0,8 m^3 coffee husk + 0,2 m^3 cattle manure + tilling intervals of 5 days	CHM5
0,8 m^3 coffee husk + 0,2 m^3 cattle manure + tilling intervals of 10 days	CHM10
0,8 m^3 coffee husk + 0,2 m^3 cattle manure + tilling intervals of 15 days	CHM15
0,8 m^3 coffee husk + 0,2 m^3 cattle manure + tilling intervals of 20 days	CHM20
1 m^3 coffee husk + tilling intervals of 5 days	CH5
1 m^3 coffee husk + tilling intervals of 10 days	CH10
1 m^3 coffee husk + tilling intervals of 15 days	CH15
1 m^3 coffee husk + tilling intervals of 20 days	CH20
Vase experiment (greenhouse):	
Soil mixed with compost CHM5 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CHM10 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CHM15 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CHM20 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CH5 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CH10 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CH15 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Soil mixed with compost CH20 in the proportion of 150 g $vase^{-1}$ (10 t ha^{-1})	
Non fertilized soil (control)	

Figure 2. Field experiment and a wooden frame with 1x1x1m dimensions.

The humidity was adjusted, where necessary, by irrigating the cells with watering pots. To verify the necessity for irrigation, the temperature presented throughout the composting process by the windrows was considered.

The temperature was measured weekly, at the center of the cells, during the 15 weeks duration of the experiment, using a mercury thermometer, range -10 to + 260 °C.

The pH in water and electrolyte conductivity were measured in proportion of 2:1 2:1 (water / volume of compost), centrifuged at 2000 rpm for 10 minutes, in samples collected every 30 days (3 readings), using a digital electrode pHmeter and a digital cell conductivitymeter respectively.

When the windrows reached constant temperature, the composts were dried and subjected to laboratory analysis for their chemical characteristics (Calcium, Boron, Zinc, Phosphorus, Potassium, Nitrogen and Carbon). The methodology used to obtain these parameters were: for Ca, Zn and P, nitric perchloric injection, using the methodology described by Abreu et al. (2001); N was measured by Kjeldahl method; the K (digested in aqua regia); C (measured by ash content); and B, according to the methodologies described by Melo e Silva (2008).

Greenhouse experiment

The experiment in greenhouse was conducted in completely randomized design (CRD), in a factorial scheme 2x4 + 1, in a total of 8 treatments + additional treatment as control (Table 2) in three replications. It was used the split-plot design with a 2x4 factorial scheme in the whole plots. The first factor was composed by the materials coffee husk and cattle manure and the second by four intervals of tilling (5, 10, 15 and 20 days), totaling eight treatments.

For the temperature variable, 15 times (split plots) were studied, for the conductivity and pH variables 3 times (split plots) were studied and for the chemical variables, final conductivity, fresh and dry biomass the factorial 2x4 was not splited in time.

This experiment was conducted from May to June 2010, the average temperature during this period was 18.5 °C in May and in June 15.0 °C and relative humidity during this period was 59% in May and 74% in June. These data were provided by the Setor de Agrometeorologia do Departamento de Engenharia (Sector of Agrometeorology at the Department of Engineering), UFLA.

The experimental units were composed of rigid polyethylene vases in a greenhouse. The pots were filled with 3L of horizon B soil due to its low fertility, plus 150g of the composts obtained in the field experiment. The soil presented the following characteristics: pH - 6.6, P - 2.9 mg dm^{-3}; K - 27 mg dm^{-3}; calcium - 3.8 cmol dm^{-3}; Mg - 0.1 cmol dm^{-3}; H + AL - 1.2 cmol dm^{-3}; cation exchange capacity (CEC) - 4 cmol dm^{-3}, cations exchange capacity (t) - 4 cmol dm^{-3}; base saturation index (V) - 76.9%; aluminum saturation index (m) - 0%; organic matter - 1.2 dag kg^{-1}; phosphorus (Prem) - 4.3 mg L^{-1} not showing Zn, Fe, Mn, Cu and Al. The quantities of the composts were applied in according to the recommendation of Ribeiro et al. (1999), for grain production (10t ha^{-1}). As a control only soil was used.

The test plant used was sorghum (*Sorghum bicolor*), which according to Souza (2001) is the recommended species, due to its rapid growth and good yields of biomass. The sown sorghum was a forage hybrid category S1, which presents good green mass production. After germination three plants were kept per pot, with humidity close to field capacity.

Thirty days after sowing, the sorghum was cut at the stem base and weighed to obtain fresh biomass. Afterwards it was dried in a kiln oven with air circulation and renewal at 70 °C, until weight stabilization to determine dry biomass.

Statistical analyses

For the data analysis the program Sisvar was used (Ferreira, 2008). Analyses of variance were performed, followed by regression analysis, Tukey and orthogonal contrast tests when necessary. The level of significance used was 5% for all tests. Figures were made in the software R (R Development Core Team, 2010).

RESULTS AND DISCUSSION

Temperature

The different tilling intervals influenced significantly the behavior of the windrow compost. However, observing Figure 3, it is verified that although there were different variations between tilling intervals during the process, all behaved similarly, stabilizing at approximately 105 days of composting.

The temperature during the period followed the general trends that, according to Ross et al. (2006) and Dias et al. (2010), are usually found in composting processes. In the first week of the process the temperature of windrows compost reached elevated temperatures (thermophilic), resulting from rapid breakdown of labile organic matter and nitrogen compounds made by microorganisms (Brito et al., 2008). The authors stress that, during the process, the organic matter becomes more stable, resulting in the decrease of microbial activity, decomposition rate of organic matter and temperature. In general, these variations in temperature during the composting process are observed in other studies, and after stabilization there is always a temperature drop of the windrow (Vuorinen; Saharinen, 1997; Heerden et al., 2002; Ross et al., 2006, Dias et al., 2010).

Electrolytic conductivity and pH through the composting process

The average electrolytic conductivity (EC) presented throughout the composting process varied between the treatments with the presence and absence of manure, being higher in windrow containing manure in all three readings (Figure 4). However, it can be observed, that a gradual decrease occurred as the material progressed in its maturation. This behavior is observed in composting processes that, according Avenimelech et al. (1996), the organic compost, before completing its maturation process, presents high salt content, due to the decomposition of organic acids and, consequently, a high EC. The EC tends to decrease and stabilize as the compost matures. Kiehl (1998) affirms that the salinity of the compost should not exceed 4000 µS cm^{-1} and that this value is stabilized around 50% of the initial reading after the maturation process. The excess of salt has adverse effects on germination and productivity of crops, either directly, hindering the absorption of water and cations nutrients by plants, or indirectly by its dispersing effect on the clay, causing disruption of the soil and damaging the infiltration water, oxygen and root growth (Tomé Júnior, 1997).The different compositions of the windrow (with and without manure) and different tilling intervals did not affect significantly the pH of the composts. However, all compositions presented decrease at the end of the period (Table 3).

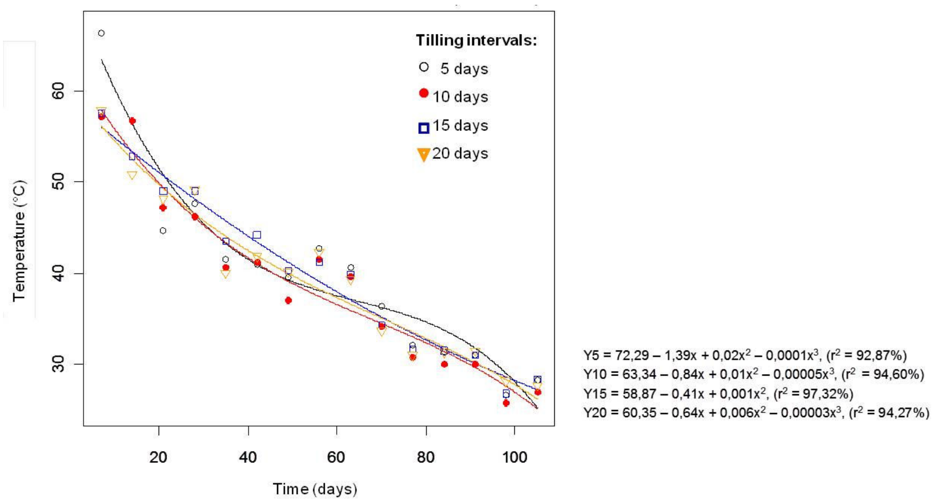

Figure 3. Temperature variation in the different tilling intervals 5, 10, 15 e 20 days.

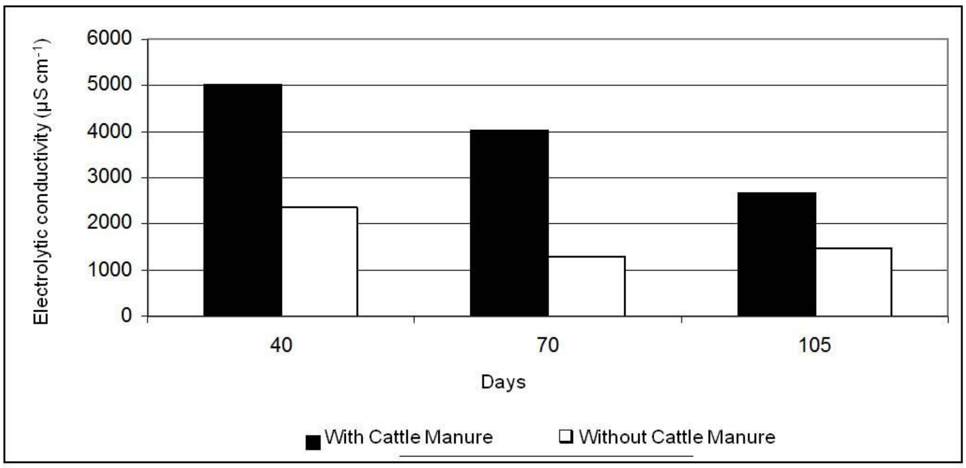

Figure 4. Presented electrolytic conductivity (µS cm^{-1}) throughout the composting period.

Table 3. Average variation of pH throughout the composting process. Averages followed by the same letter do not differ among themselves by the Tukey test (5%).

Collection	pH
40 days	7.77[a]
70 days	7.77[a]
105 days	7.51[b]

Although pH has been alkaline throughout the process, the observed values are within the range considered optimal for the microorganisms responsible for composting, according Fialho et al. (2005), lies between 5.5 and 8.5. These results are similar to those obtained by Lima et al. (2009). This behavior during the composting process is attributed to a combination of factors, according to Kiehl (1998) and Iyengar and Bhave (2006), occur at the beginning of the composting, with the formation of soluble acid and, as the process progresses, there is a greater concentration of bases, helping to obtain a more alkaline material.

Electrolytic conductivity and pH at the end the composting process

The different compositions of the compost pile (with manure) and different tilling intervals significantly affect the EC of the compounds obtained. Figure 5 shows the EC of each compost with manure in the end of the experiment, after being subjected to different tilling intervals. It is verified that with shorter tilling intervals, i.e. more windrow tillings, the EC presented is lower. As for the compost without manure, it showed no significant differences in the different tilling intervals. Similar results were observed by Brito et al. (2009), who, when comparing different tilling intervals, obtained lower readings of EC in the windrow with higher tilling frequency. This behavior may be attributed to a greater influence on compost maturity when it is more tilled, causing the decrease of EC.

Chemical characteristics of composts

Analyzing the data obtained, it was observed that there was significant interaction between variables with and without manure and tilling intervals of composted material only for phosphorus (total). For the variable tilling intervals was significant only for nitrogen (total), while for the presence and absence of manure there was significant effect on phosphorus, zinc, boron, carbon and C / N ratio.

Phosphorus

Analyzing Figure 6, it is verified that when adding manure to coffee husk, the composting process did not influence the P content of the composts, possibly by the presence of this element in the manure, while in compost with only coffee husk, the greater the range of tillage, the lower the P content of the compost. It may be inferred that the more the pile is tilled, the more P is released from the compost, containing only coffee husks.

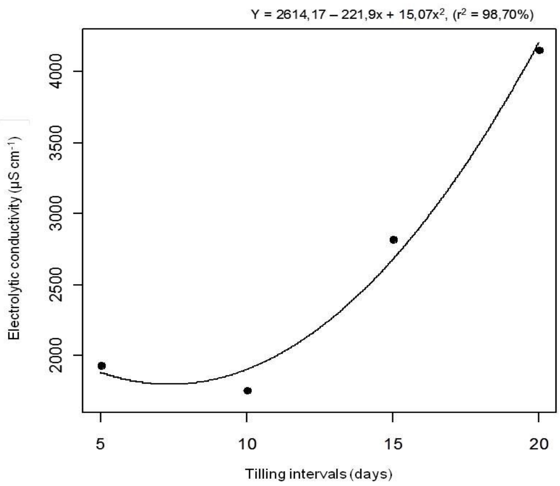

Figure 5. Presented electrolytic conductivity (µS cm^{-1}) in the different tilling intervals in the final compost with manure added.

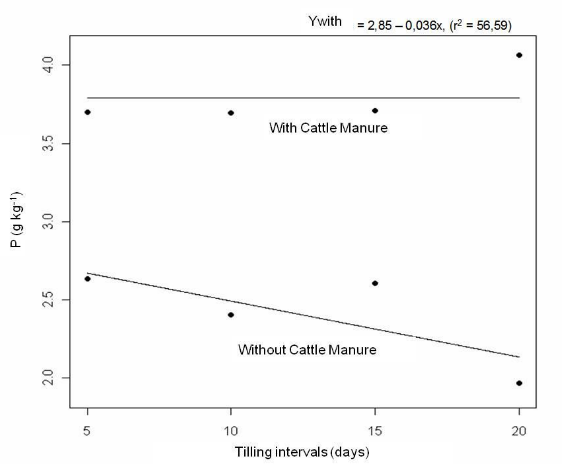

Figure 6. P content in the different tilling intervals.

Nitrogen

For N, it is observed in Figure 7 that composts with a tilling interval of 20 days presented higher N contents. The different tilling intervals, an activity directly related to the aeration, influenced the behavior of N, i.e. the longer the tilling intervals, the lower the aeration, higher N content. Guardia et al. (2008) observed greater N losses to aerate the windrow compost, similar results to those found in this work. Likewise, Brito et al. (2008), comparing static windrow compost and tilled, verified smaller losses of N in the static windrow. These results indicate that the activity of tilling must be done with discretion, thus reducing N losses, but should be undertaken to fulfill its role as aerator, temperature, humidity and uniformity controller of the material.

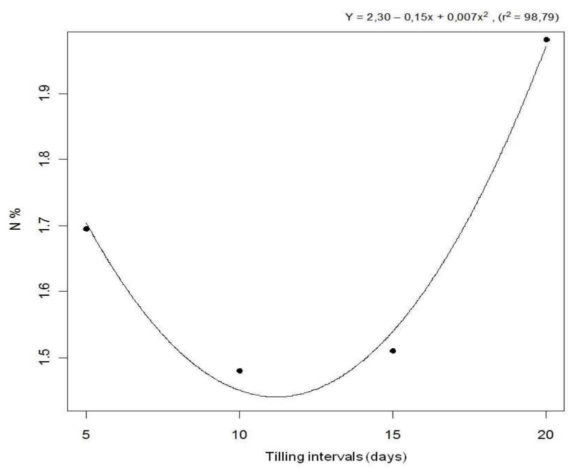

Figure 7. N content in the different tilling intervals.

Carbon, Zinc, Boron, Phosphorus, Potassium e Calcium

The addition of manure in composting of coffee husk provided higher levels of P and Zn and decrease in the B and C contents (Table 4). This result may be explained, by the fact that manure is rich in P and Zn and coffee husk contains more B and C than manure (Table 1). Therefore, when adding 20% manure to coffee husk, there was a relative decrease of the contents of the elements on which the husk is richer. On the other hand, when cattle manure was not added to coffee husk, there was no addition of nutrients present (P and Zn).

Observing the data on Table 4, it is verified that composts with addition of manure had a lower C / N ratio. This result may be explained by the addition of cattle manure to coffee husk, enriching it with nitrogen. Loureiro et al. (2006), when comparing different substrates for the production of lettuce, had higher levels of nutrients in the compost with cattle manure added to it. The authors also obtained higher rates of decomposition in the compost with manure, which resulted in a final product with lower C / N ratio. According to Fialho et al. (2010), the efficiency of the composting process depends on the type of substrate used. The author emphasizes that the ability of microorganisms to degrade the organic material is directly related to the C / N ratio, but this parameter must be seen in association with others to evaluate the maturity of the final product.

Table 4. Presented differences between the final composts in relation to the nutrients C, P, Ca, K, Zn, B e C/N ratio. Within each column, the averages followed by the same letter do not differ among themselves by the Tukey test (5%).

	C	P	Ca	K	Zn	B	C/N ratio
	%	g kg^{-1}			mg kg^{-1}		
With manure	21^{b}	3.8^{a}	9.2^{a}	5.0^{a}	115.6^{a}	5.3^{b}	13.28^{b}
Without manure	28^{a}	2.4^{b}	7.9^{a}	5.1^{a}	57.3^{b}	12.2^{a}	16.46^{a}

The C / N ratio is often used to describe the decomposition of organic waste and its stabilization, i.e. a larger C / N ratio implies low rates of mineralization and may result, after its application in soil, in N deficiency (Bernal et al., 1998). However, the authors argue that by adding materials to soil with C / N ratio < 15, there is no risk of N immobilization, but attention should be paid for materials with smaller C / N ratio due to the risks of groundwater contamination by nitrate leaching. Since Brazilian legislation requires that for its marketing, organic fertilizers must present a C / N ratio less than 20 / 1. In this work the highest rates of C / N ratio were observed in the composts without addition of manure, on average 16 / 1, value in accordance with the legislation requirements.

As for K and Ca, there was no influence of the studied the variables. Despite the great content of K presented by the coffee husk, it is interesting to note that this element, very mobile and easily leachable, must have suffered leaching due to rainfall, time during which the experiment was conducted (Figure 1). Ernani et al. (2007) affirm that there is no K in abiotic organic fraction, since it does not integrate any stable organic compound, is washed off from the organic material after the death of cells.

Fresh and dry biomass of sorghum

Analyzing the data on Table 5, it is possible to observe that, both for fresh and dry biomass, the compounds from addition of manure to coffee husk (CHM 5, 10, 15 and 20), independent of the tilling intervals, provided better results than the compounds only with coffee husk (CH 5, 10, 15 and 20).

Table 5. Fresh and dry biomass values in the different organic composts. Within each column, the averages followed by the same letter do not differ among themselves by the Tukey test (5%).

Added compost	Fresh biomass	Dry biomass
	(g)	
CHM5	1.91[a]	0.24[a]
CHM10	1.47[a]	0.18[a]
CHM15	1.35[a]	0.17[a]
CHM20	1.49[a]	0.19[a]
CH5	1.04[b]	0.13[b]
CH10	1.12[b]	0.14[b]
CH15	1.05[b]	0.14[b]
CH20	1.17[b]	0.15[b]

The control average (0.93 g) did not differ from the average of the factorial (1.33 g) for fresh biomass, according to the F test at 5% significance level. However, for dry biomass, the control average (0.11 g) differed from the other treatments. On average, the biomass production of organic composts was 0.06 g or 35% above control.

According to Abdelhamid et al. (2004), the addition of compost resulted in higher production of agricultural crops, the authors stress that composts with lower C / N ratio result in higher production of agricultural crops. This result was similar to the one obtained by Rashid et al. (2001), who affirm that many studies conclude that the addition of compost increases the production of agricultural crops.

The low growth rates in the vase experiment is mainly due to the period in which it was conducted, during May and June, when average temperatures were 18.5 ° C and 15.0 ° C respectively, as sorghum is demanding in heat.

CONCLUSIONS

1. Longer tilling intervals reduce the nitrogen loss, besides decreasing the necessity of labor.
2. Organic composts obtained with shorter tilling intervals present a lower electrolytic conductivity.
3. The addition of manure to the coffee husk provides reduction in the C / N ratio, increasing, therefore, the mineralization ratio of organic compost.
4. In the sorghum cropping, the composts deriving from the mix of coffee husk with manure provide better results for fresh and dry biomass.

ACKNOWLEDGMENTS

To the Universidade Federal de Lavras (Federal University of Lavras) (UFLA), the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes), for granting scholarships, and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), for making this study possible.

REFERENCES

ABDELHAMID, M. T.; HORIUCHI, T.; OBA, S. Composting of rice straw with oilseed rape cake and poultry manure and its effects on faba bean (*Vicia faba* L.) growth and soil properties. **Bioresource Technology**, Essex, v. 93, n. 2, p. 183-189, Jun. 2004.

ABREU, M. F.; ABREU, C. A.; ANDRADE, J. C. Determinação de fósforo, potássio, cálcio, magnésio, enxofre, cobre, ferro, manganês, zinco, níquel, cádmio, cromo e chumbo em ácido nítrico usando métodos da US - EPA. In: RAIJ, B. van; ANDRADE, J. C.; CANTARELLA, H; QUAGGIO, J. A. (Ed.). **Análise química para avaliação da fertilidade de solos tropicais**. Campinas: Instituto Agronômico de Campinas, 2001. cap. 17, p. 251-261.

AVENIMELECH, Y.; BRUNER, M.; EXRONY, I.; SELA, R.; KOCHBA, M. Stability indexes for municipal solid waste composting. **Compost**

Science & Utilization, Emmaus, v. 4, n. 2, p. 13-20, 1996.

BENITO, M.; MASAGUER, A.; MOLINER, A.; ARRIGO, N.; PALMA, R.M. Chemical and microbiological parameters for the characterisation of the stability and maturity of pruning waste compost. **Biology and Fertility of Soils**, Berlim, v. 37, n. 3, p. 184-189, 2003.

BERNAL, M.P.; PAREDES, C.; SANCHEZ-MONEDERO, M.A.; CEGARRA, J. Maturity and stability parameters of composts prepared with a wide range of organic wastes. **Bioresource Technology**, Essex, v. 63, n. 1, p. 91-99, 1998.

BRITO, L.M.; AMARO, A.L.; FERNANDES, A.S. Efeito do arejamento no processo de compostagem da fracção sólida do chorume de pecuária leiteira. **Revista de Ciências Agrárias,** Lisboa, v.32, n.1, p.298-311, 2009.

BRITO, L.M.; COUTINHO, J.; SMITH, S.R. Methods to improve the composting process of the solid fraction of dairy cattle slurry. **Bioresource Technology**, Essex, v.99, n.18, p. 8955-8960, 2008.

CARVALHO, V.S.; TELLA, M.A.P. **Sociedade de consumo e sustentabilidade planetária**: consumo, lixo e meio ambiente. São Paulo: Secretaria do Meio Ambiente/CEDEC/ Coordenadoria de Educação Ambiental, 1997. 122 p.

COMPANHIA NACIONAL DE ABASTECIMENTO - CONAB. Acompanhamento da Safra Brasileira. **Café Safra 2009, primeira estimativa, janeiro/2010**. Brasília, 2010. 18 p.

DANTAS, A.A.A.; CARVALHO, L.G.; FERREIRA, E. Classificação e tendências climáticas em Lavras-MG. **Ciência e Agrotecnologia**, Lavras, v.31, n.6, p.1862-1866, 2007.

DIAS, B.O.; SILVA, C.A.; HIGASHIKAWA, F.S.; ROIG, A.; SÁNCHEZ-MONEDERO, M.A. Use of biochar as bulking agent for the composting of poultry manure: Effect on organic matter degradation and humification. **Bioresource Technology**, Essex, v.101, n.4, p.1239-1246, 2010.

ERNANI, P.R.; ALMEIDA, J.A.; SANTOS, F.C. Potássio. In: NOVAIS, R.F.; ALVAREZ, V.H.; BARROS, N.F.; FONTES, R.L.F.; CANTARUTTI, R.B.; NEVES, J.C.L. (Eds.). **Fertilidade do solo**. Viçosa, MG: Sociedade Brasileira de Ciência do Solo, 2007. cap. 9, p.551-594.

FERREIRA, D.F. SISVAR: um programa para análises e ensino de estatística. **Revista Cientifica Symposium**, Lavras, v.6, n.2, p.36-41, 2008.

FIALHO, L.L.; SILVA, W.T.L.; MILORI, D.M.B. P.; SIMÕES, M.L.; MARTIN-NETO, L. Characterization of organic matter from composting of different residues by physicochemical and spectroscopic methods. **Bioresource Technology**, Essex, v. 101, n. 6, p. 1927-1934, Mar. 2010.

FIALHO, L.L.; SILVA, W.T.L.; MILORI, D.M.B.P.; MARTIN-NETO, M.L. **Monitoramento químico e físico do processo de compostagem de diferentes resíduos orgânicos**. São Carlos: EMBRAPA, 2005. (Circular técnica, 29).

GUARDIA, A.; PETIOT, C.; ROGEOU, D.; DRUILHE, C. Influence of aeration rate on nitrogen dynamics during composting, **Waste Management**, Oxford, v.28, n.3, p.575-587, 2008.

HEERDEN, I. van; CRONJÉ, C.; SWART, S. H.; KOTZÉ, J.M. Microbial, chemical and physical aspects of citrus waste composting. **Bioresource Technology**, Essex, v.81, n.1, p.71-76, 2002.

HUTCHISON, M.L.; WALTERS, L.D.; AVERY, S.M.; MUNRO, F.; MOORE, A. Analyses of livestock production, waste storage, and pathogen levels and prevalences in farm manures. **Applied and Environmental Microbiology**, Washington, v.71, n.3, p.1231-1236, 2005.

IYENGAR, S.R.; BHAVE, P.P. In-vessel composting of household wastes. **Waste Management**, Oxford, v.26, n.10, p.1070-1080, 2006.

KIEHL, E.J. **Manual de compostagem**: maturação e qualidade do composto. Piracicaba: Ed. do Autor, 1998. p. 171.

KIEHL, J.E. **Fertilizantes orgânicos**. Piracicaba: Agronômica Ceres, 1985. 492 p.

LAZCANO, C.; GÓMEZ-BRANDÓN, M.; DOMÍNGUEZ, J. Comparison of the effectiveness of composting and vermicomposting for the biological stabilization of cattle manure. **Chemosphere**, Oxford, v.70, n.6, p.1013-1019, 2008.

LIMA, C.C., MENDONÇA, E.S.; SILVA, I.R.; SILVA, L.H.M.; ROIG, A. Caracterização química de resíduos da produção de biodiesel compostados com adição mineral. **Revista Brasileira de Engenharia Agrícola e Ambiental**, Campina Grande, v.13, n.3, p.334-340, 2009.

LOUREIRO, D. C.; AQUINO, A. M.; DE-POLLI, H.; LEAL, M. A. A.; CARMO, M. V. **Produção de mudas de beterraba e alface com resíduos orgânicos domésticos**. Seropédica: EMBRAPA, 2006. 4 p. (Comunicado técnico, 90).

MELO, L.C.A.; SILVA, C.A. Influência de métodos de digestão e massa de amostra na recuperação de nutrientes em resíduos orgânicos. **Química Nova**, São Paulo, v.31, n.3, p.556-561, 2008.

PEREIRA NETO, J.T. **Um sistema de reciclagem e compostagem, de baixo custo, de lixo urbano para países em desenvolvimento**. Viçosa, MG: UFV, 1996. 56 p.

RASHID, M.A.; HORIUCHI, T.; OBA, S. Enrichment of rice straw compost by adding cow dung and soybean plants and it's effects on wheat yield and soil nutrients. **Tokai Journal of Crop Science**, Toquio, v. 131, p. 3- 9, Dec. 2001.

R Development Core Team. **R:** a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2010. 409p.

RIBEIRO, A.C.; GUIMARÃES, P.T.G.; ALVAREZ, V.H. **Recomendações para o uso de corretivos e fertilizantes em Minas Gerais**: 5ª aproximação. Viçosa, MG: CFSEMG, 1999. 359p.

ROSS, M.; GARCIA, C.; HERNÁNDEZ, T. A full-scale study of treatment of pig slurry by composting: kinetic changes in chemical and microbial properties. **Waste Management**, Oxford, v.26, n.10, p.1108-1118, 2006.

SILVA, C.A. Uso de resíduos orgânicos na agricultura. In: SANTOS, G.A.; SILVA, L.S.; CANELLAS, L.P.; CAMARGO, F.A.O. (Ed.). **Fundamentos da matéria orgânica**: ecossistemas tropicais e subtropicais. Porto Alegre: Metrópole, 2008. cap 32, p.597-624.

SOUZA, J.C. **Uso de composto orgânico proveniente de lixo urbano selecionado como agente mitigador da biodisponibilidade de Cádmio**. 2001. 98 p. Dissertação (Mestrado em Geoquímica e Meio Ambiente) – Universidade Federal da Bahia, Salvador, 2001.

TOMÉ JÚNIOR, J.B. **Manual para interpretação de análise de solo**. Guaíba: Agropecuária, 1997. 247 p.

VENTURIM, J.B. **Gestão de Resíduos Orgânicos Produzidos no Meio Rural:** o caso do beneficiamento do café. 2002. 101 f. Tese (Doutorado em Engenharia de Produção) - Universidade Federal de Santa Catarina, 2002.

VUORINEN, A.H.; SAHARINEN, M.H. Evolution of microbiological and chemical parameters during manure and straw co-composting in a drum composting system. **Agriculture, Ecosystems and Environment**, Amsterdam, v. 66, n. 1, p. 19-29, 1997.

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