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# ORGANIC COMPOUND IN SOIL CONDITIONING AND GROWTH AND PRODUCTION OF PEPPER[1]

## *COMPOSTO ORGÂNICO NO CONDICIONAMENTO DO SOLO E CRESCIMENTO E PRODUÇÃO DE PIMENTÃO*

**Fernanda de Sousa Veloso[2], Jefrejan Souza Rezende[3], Ana Karina Silva Costa[4], Bianca Alves Custódio[4], Cássio de Moura Santos[5], Daniel de Moura Silva[4], Ronilson Carvalho Veloso[4] e Lucila de Sousa Nunes[4]**

**ABSTRACT**

Organic production has been a competitive and sustainable alternative for increase productivity of pepper. Among organic waste, compounds originating from composting stand out. In this work, the effect of applying organic compound on soil conditioning and on the growth and production of peppers. The experiment took place in protected environment at the State University of Piauí, in Picos-PI. The experimental design was completely randomized, with five treatments (0; 2; 4; 8 and 12 kg $m^{-2}$) and five replications. 90 days before transplanting, organic compost was produced and applied to the soil 30 days before transplanting. 45 days before transplanting, seedlings were produced in trays, which were transplanted into 6 $dm^3$ pots. The variables evaluated were: Plant height, stem diameter, number of leaves and fruits per plant, fresh mass and aerial dry mass, fresh fruit mass, productivity and soil organic matter, in first cultivation cycle. In the second cycle, in addition to the variables mentioned, root length and root volume were evaluated. The organic compound provided improvements in the growth and production of peppers and increased soil organic matter values in the first cultivation cycle, where the dose of 12 kg $m^{-2}$ was recommended for pepper production under the study conditions. However, there was no influence of organic compound in the second cultivation cycle, suggesting that this fertilizer, as it has a low residual effect, should be applied to each pepper cultivation cycle.

**Keywords:** *Capsicum annum L.*, Composting, Organic fertilization, Semiarid.

***RESUMO***

*A produção orgânica tem sido uma alternativa competitiva e sustentável para aumentar a produtividade de pimentão. Dentre os resíduos orgânicos, destacam-se os compostos oriundos da compostagem. Avaliou-se o efeito da aplicação do composto orgânico no condicionamento do solo e crescimento e produção de pimentão. O experimento ocorreu em ambiente protegido na Universidade Estadual do Piauí, em Picos-PI. O delineamento experimental foi o inteiramente casualizado, com cinco tratamentos (0; 2; 4; 8 e 12 kg $m^{-2}$) e cinco repetições. Aos 90 dias antes do transplantio produziu-se o composto orgânico que foi aplicado no solo 30 dias antes do transplantio. Aos 45 dias antes do transplantio realizou-se a produção de mudas*

1 Trabalho de Iniciação Científica, Universidade Estadual do Piauí - UESPI.

2 Bolsista PIBIC-UESPI. Graduanda em Engenharia Agronômica - UESPI, Picos, PI. E-mail: fernandaveloso@aluno.uespi.br. ORCID: 0000-0001-9649-2908

3 Orientador. Docente do curso de Engenharia Agronômica - UESPI, Picos, PI. E-mail: jefrejansouza@pcs.uespi.br. ORCID: 0000-0002-2606-9386

4 Graduando(a) em Engenharia Agronômica - UESPI, Picos, PI. E-mails: anakcosta@aluno.uespi.br; biancacustodio@aluno.uespi.br; danielmsilva@aluno.uespi.br; ronilsonveloso@aluno.uespi.br; lucilanunes@aluno.uespi.br. ORCID: 0000-0001-9842-0799; 0009-0003-0909-041X; 0000-0003-1589-8346; 0000-0002-1739-7791; 0000-0002-0909-4352

5 Engenheiro Agrônomo - UESPI, Picos, PI. E-mail: cassiomourasantos18@gmail.com. ORCID: 0000-0002-8217-0534

*em bandejas, que foram transplantadas para vasos de 6 dm³. Avaliaram-se as variáveis: Altura de Planta, diâmetro do caule, número de folhas e de frutos por planta, massa fresca e massa seca aérea, massa fresca do fruto, produtividade e matéria orgânica do solo, no primeiro ciclo de cultivo. No segundo ciclo, além das variáveis mencionadas, avaliaram-se o comprimento radicular e o volume radicular. O composto orgânico proporcionou melhoria no crescimento e produção de pimentão e aumentou os valores de matéria orgânica do solo, no primeiro ciclo de cultivo, onde a dose de 12 kg m$^{-2}$ foi à recomendada para a produção de pimentão nas condições do estudo. No entanto, não houve influência do composto orgânico no segundo ciclo de cultivo, sugerindo que esse adubo, por possuir baixo efeito residual, deve ser aplicado a cada ciclo de cultivo do pimentão.*

***Palavras-chave:*** *Capsicum annum L., Compostagem, Adubação orgânica, Semiárido.*

## INTRODUCTION

Pepper (*Capsicum annum* L.) occupy a prominent position among cultivated vegetables, being one of the ten most economic and social importance in Brazil (PASSOS *et al*., 2023). Its frequent presence on Brazilian tables contributes to a healthier diet, in addition to perform a significant function in generating employment and income for several families (GIACOMIN *et al*., 2021).

Pepper is a climacteric fruit, which presents peak in ethylene and respiration after disconnection from the mother plant, which can result, without adequate management, in substantial losses (MOREIRA *et al*., 2017; CHAGAS *et al*., 2018). The low productivity of this crop may be associated with factors such as: climate, low soil fertility, low technological production quality and inadequate management of soil correction and fertilization practices (SILVA *et al*., 2019b; REZENDE *et al*., 2021). According to Costa *et al*. (2019), This vegetable requires good chemical and physical conditions in the cultivation medium for fruit growth, with emphasis on adequate nutritional management, which involves the type of fertilizer, quantity and form of nutrient application (COSTA *et al*., 2019).

In addition, the high requirement for nutrients results in a high demand for mineral fertilizers in the production process (CASAIS *et al*., 2018; REZENDE *et al*., 2021). This leads to a large scale of imports of these chemical fertilizers, as Brazil does not produce enough inputs (CARVALHO; CASTRO, 2022), which results in increased production and commercialization costs and environmental impacts.

Given this, organic production has been a competitive and sustainable alternative for increasing the productivity rates of this crop. According Silva *et al*. (2019a), the use of organic fertilizer has provided satisfactory production, due to the facility of cultivation in small areas and short cycle (SANTOS *et al*., 2020).

Among organic waste, the compounds produced by the composting process stand out, resulting from the degradation of organic waste in the presence of oxygen (BRASIL, 2017). Composting is the aerobic process of microbial decomposition of organic matter, where ideal conditions are created so that the various decomposer organisms present in nature can degrade and stabilize organic waste under controlled and safe conditions for human health (SEDIYAMA *et al*. 2014). This results in production of organic fertilizers and soil conditioners, which promote nutrient recycling, protect soil against erosion and reduce nutrient loss, thus reducing the need for mineral fertilizers (BRASIL, 2017).

Organic compounds also have excellent physical and chemical properties, which allows the soil to increase its cation exchange capacity, accumulate organic matter and improve its physical structure (MEDEIROS *et al*., 2019).

The abundance of animal and vegetable waste in the semi-arid region, the facility of production and the low cost of the process make the organic compound a potential fertilizer for the production of pepper by families in the semi-arid region of Piauí (SEDIYAMA *et al*., 2014).

Therefore, the objective of this work was to evaluate the effect of applying organic compost on soil conditioning and on growth and production of pepper.

## MATERIALS AND METHODS

The study was carried in the experimental area of the Agronomy Course at the State University of Piauí, *Campus* Professor Barros Araújo (07°02'51" S, 41°32'30" W, altitude of 342 m a.s.l), in the municipality of Picos-PI, in protected environment, from February to September 2023. The climate is of the BSh type, characterized as semi-arid, with distinct dry and wet seasons and average annual rainfall ranging from 600 to 700 mm (ALVAREZ *et al*., 2013).

The experimental design used was completely randomized, with five treatments and five replications, totaling 25 experimental plots. The evaluated treatments were composed of five organic compound doses (0; 50; 100; 200 and 300% of the recommended dose), which corresponded to 0; 2; 4; 8 and 12 kg m$^{-2}$. The recommended dose was defined according to Trani (2007), which corresponded to 4 kg m$^{-2}$.

The soil used was collected in area of native vegetation, belonging to the State University of Piauí in the 0-20 cm layer, and sent to the laboratory for chemical and grain size characterization (Table 1), according to Teixeira *et al* (2017).

**Table 1 -** Chemical and grain size characterization of soil in the 0-20 cm layer.

| pH | P | $K^+$ | $Ca^{2+}$ | $Mg^{2+}$ | $Al^{3+}$ | H+Al | SB | CEC | V | OM | Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $H_2O$ | mg dm$^{-3}$ | ---------------cmol$_c$dm$^{-3}$--------------- | | | | | | | ---------------%--------------- | | | | |
| 5.87 | 22.10 | 0.11 | 3.37 | 0.75 | 0.00 | 2.41 | 4.23 | 6.64 | 63.70 | 0.66 | 71,80 | 9.10 | 19.10 |

pH in $H_2O$, phosphorus (P), potassium ($K^+$), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), aluminum ($Al^{3+}$), hydrogen+aluminium (H+Al), sum of bases (SB), cation exchange capacity (CEC), base saturation (V); organic matter content (OM). Sand: 58.09%; Silt: 19.76%, Clay: 22.15%
Source: Author Construction

90 days before transplanting, organic compost was produced in the open air through the construction of compost piles, formed by 20 cm layer of dry plant material and a layer formed by food

waste and bovine manure. These piles were interspersed with nitrogen-rich wet materials and carbon-rich dry materials. Aeration was carried out by regular stirring. Layers were moistened and turned to ensure uniform decomposition, maintaining ideal humidity and aeration conditions until point of maturation and stabilization (KIEHL, 1998).

The chemical composition of the organic compound is found in table 2.

**Table 2 -** Average chemical characterization of domestic organic compound.

| pH | N | P | K | Ca | Mg | C/N |
|---|---|---|---|---|---|---|
| $CaCl_2$ | ---------------%--------------- | | | | | |
| 6.80 | 1.81 | 0.87 | 1.54 | 1.84 | 0.45 | 10.60 |

Source: Adapted from Anacleto *et al*. (2018)

60 days before transplanting, common lime was applied (PRNT 65%), with the aim of increasing base saturation to 70% (TRANI, 2007).

45 days before transplanting, pepper seedlings of Cascadura Ikeda cultivar were produced. For this, the seeds were sown in plastic trays with 92 cells, at density of three seeds per cell with a substrate of carbonized rice straw and soil (REZENDE *et al*., 2021). 15 days after emergence, thinning was performed, leaving one plant per pot.

30 days before transplanting, the doses of organic compound were weighed on precision scale at 0.05 kg and incorporated into the soil in 6 $dm^3$ pots.

45 days after seedling production, transplanting was carried for the pots. Once day, manually, a volume of 270 mL of water per pot was applied, which corresponded to 70% of pot capacity. Weeds were removed manually experiment during.

75 days after transplanting, two cultivation cycles were evaluated. In the first cycle, following variables were evaluated: Plant height (PH, cm), stem diameter (SD, mm), number of leaves (NL), number of fruits per plant (NFP), aerial fresh mass (AFM, g $plant^{-1}$), aerial dry mass (ADM, g $plant^{-1}$), fresh fruit mass (FFM, g $plant^{-1}$), productivity (PD, t $ha^{-1}$) and soil organic matter content (SOM, g $kg^{-1}$). In second cycle, in addition to the cited variables, root length (RL, cm) and root volume (RV, $cm^3$) were evaluated, except ADM and SOM content.

To determine AP, a ruler graduated in centimeters was used, measuring from the ground to base of the last expanded leaf. For DC, a digital caliper was used at a height of 2 cm to soil. For NF and NFP, count was carried out. For AFM, aerial part was cut close to the soil and placed in paper bags and weighed on analytical balance with accuracy of 0.0001g. Subsequently, to determine ADM, aerial parts were drying in air circulation oven at 65 ºC for 72 hours and weighed on analytical balance. For FFM, the fruits each plot were weighed on 0.05 kg precision balance. Fruit mass was multiplied by number of plants per hectare, to determine the PD. RL was measured by a measure tape. To determine the RV, a 100 mL beaker with water was used, where the volume displaced after immersion of root was recorded To determine SOM, soil samples were collected in each plot and sent to the laboratory for determination of soil organic carbon (SOC) by oxidation of the organic matter by potassium dichromate ($K_2Cr_2O_7$) 0.020 mol $L^{-1}$ and titrated with ammonium ferrous sulphate (Mohr's salt) 0.005 mol $L^{-1}$ (YEOMANS; BREMNER, 1988). Subsequently, SOC values were multiplied by 1.72 to determine the SOM. To determine the RV, a 100 mL beaker with water was used, where the volume displaced after immersion of root was recorded.

The data were submitted to analysis of variance using the F test (P≤0.05). For the doses of the organic compound, polynomial regression analysis was used at 5% significance.

## RESULTS AND DISCUSSION

According the resume of analysis of variance (Table 3), for the first cultivation cycle, there was effect of the organic compound to stem diameter (SD), aerial fresh mass (AFM), aerial dry mass (ADM), fruit fresh mass (FFM), productivity (PD) and soil organic matter (SOM). However, there was no influence of the organic compound to plant height (PH), number of leaves (NL) and number of fruits per plant (NFP).

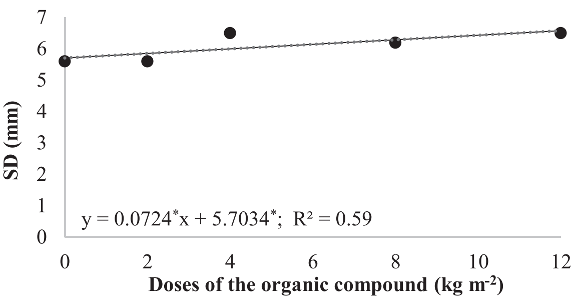
**Table 3 -** Resume of analysis of variance, in the first cultivation cycle for plant height (PH), number of leaves (NL), number of fruits per plant (NFP), stem diameter (SD), aerial fresh mass (AFM), aerial dry mass (ADM), fruit fresh mass (FFM), productivity (PD) and soil organic matter (SOM) of pepper in response the application of organic compound.

| Variation sources | p-value <0,05 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PH | NL | NFP | SD | AFM | ADM | FFM | PD | SOM |
| | -cm- | | | -mm- | ------g planta$^{-1}$------ | | | kg ha$^{-1}$ | g kg$^{-1}$ |
| Organic compound | 0.81$^{ns}$ | 0.52$^{ns}$ | 0.48$^{ns}$ | 0.00$^{*}$ | 0.03$^{*}$ | 0.01$^{*}$ | 0.02$^{*}$ | 0.02$^{*}$ | 0.00$^{*}$ |
| CV(%) | 21.10 | 24.91 | 25,24 | 6.58 | 21.71 | 24.37 | 35.16 | 35.16 | 6.56 |

$^{*}$Significant at the level of 5%; $^{ns}$Not significant by F-test. CV - Coefficient of variation.
Source: Author Construction.

For SD, the dose of 12 kg $m^{-2}$ of the organic compound provided the highest value of this variable, with average of 6.57 mm, presenting an increase of 15.19% compared control (Figure 1).

**Figure 1 -** Stem diameter (SD) of pepper, in the first cycle, in function of doses of the organic compound.

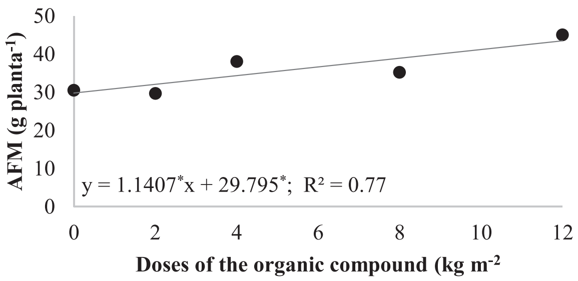



$^{*}$Significant at 5% probability.
Source: Author Construction.

The organic compound has high concentrations of potassium (K), phosphorus (P) and calcium (Ca) that increase cell elongation resulting in greater diameter (VASCONCELOS *et al*., 2017). According to Santana *et al*. (2012), the increase in SD probably occurs due to the addition of organic matter to the soil, which brings numerous beneficial effects, such as improving soil properties, thus increasing the supply of nutrients to plants. Ziech *et al*. (2014), evaluating lettuce yield found positive effects of organic fertilizers on increasing SD. According to Soares *et al*. (2016) the development of stem diameter favors greater density, preventing tipping due to adverse weather conditions and contributing to increased productivity.

Regarding the AFM, the dose of 12 kg m$^{-2}$ of the organic compound provided the highest value of this variable, with average of 43.48 g plant$^{-1}$, being 45.93% higher than the control (Figure 2).

**Figure 2 -** Aerial Fresh Mass (AFM) of pepper, in the first cycle, in function of doses of the organic compound.




*Significant at 5% probability.
Source: Author Construction.

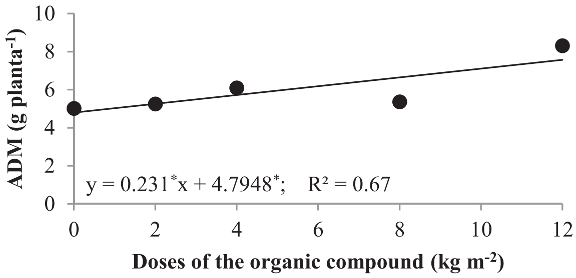
Organic matter, when applied to the soil is decomposed and releases nutrients such as P, K and magnesium (Mg), which have fundamental role in improving the photosynthetic capacity of leaves, maximizing the absorption of nutrients that are used for the formation of organic compounds by the plant, resulting in greater development of green biomass in the aerial part of the crop (BONFIM-SILVA *et al*., 2015).

Souza *et al*. (2013) found that the application of organic fertilizer increased biomass production in lettuce. The authors attributed such increases to the increase in concentrations of P, K, Ca and Mg, thus causing a balance of these nutrients (REBOUÇAS et al., 2013).

According to Oliveira *et al*. (2014), the organic compound can positively influence soil moisture retention and improve soil characteristics, thus contributing to the increase in fresh mass of the aerial part.

The application of 12 kg m$^{-2}$ of the organic compound provided the highest average to ADM, with value of 7.57 g plant$^{-1}$, an increase of 57.88% compared control (Figure 3).

**Figure 3 -** Aerial Dry Mass (ADM) of pepper, in the first cycle, in function of doses of the organic compound.

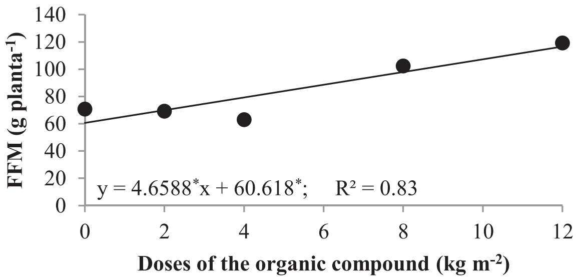



*Significant at 5% probability.
Source: Author Construction.

Products that have high levels of N, such as organic compounds, are more efficient in initial formation of plants (LOVELL; MOORE, 1970; GECKEL, 2020). According to Rezende *et al.* (2021), this type of fertilizer is a soil conditioner and supplier of essential elements to the plant, which directly reflects in improvement dry biomass of the crop.

In relation to FFM, the dose of 12 kg $m^{-2}$ of the organic compound provided the highest average of this variable, with value of 116.52 g $plant^{-1}$, obtaining an increase of 92.22% compared control (Figure 4).

**Figure 4 -** Fresh Fruit Mass (FFM) of pepper, in the first cycle, in function of doses of the organic compound.

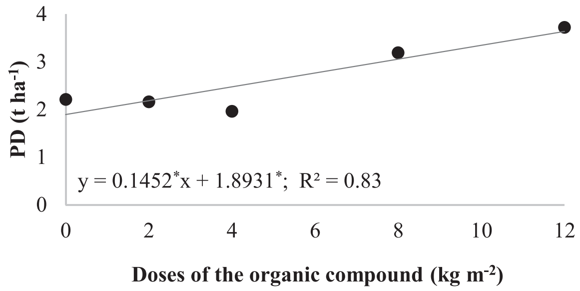



*Significant at 5% probability.
Source: Author Construction.

The effects of organic fertilizers on FFM are still little evidenced, however, Faria; Pereira; Possídio, (1995) verified positive influence of P, common element in organic compounds, on the increase in fruit mass. In addition, the authors indicate that the positive results may be associated with increase in the levels of N, P and K available in the compounds originating from composting process.

Maximum PD of pepper (3.64 t $ha^{-1}$) occurred with the application of 12 kg $m^{-2}$ of the organic compound, which provided an increase of 92.03% in relation to the control (Figure 5).

**Figure 5 -** Productivity (PD) of pepper, in the first cycle, in function of doses of the organic compound.



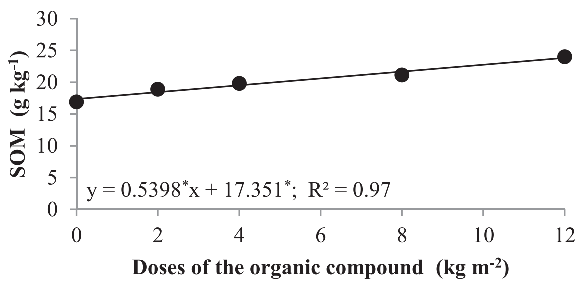

*Significant at 5% probability.
Source: Author Construction.

The response of pepper regarding productivity may be related the characteristics of organic compounds, which are capable of supply plants with macronutrients, due to increase in available N, P and K levels (CAMARGO, 1986), in addition to improving the soil physical properties, making these elements highly available.

According to Andrade *et al*. (2020), the production of fruits per plant and the productivity of pepper commercial fruits responded satisfactorily to the use of bovine manure, organic fertilizer widely used in the composting process. This may occur due to the adequate quantity of this good quality product, capable of supply the plants macronutrient needs, the greater availability of these elements and improvement in soil physical properties (CAMARGO, 1986).

For the SOM variable, the dose of 12 kg $m^{-2}$ of the organic compound provided the highest average (23.82 g $kg^{-1}$), with increase of 37.33%, in relation to the control (Figure 6).

**Figure 6 -** Soil Organic Matter (SOM), in the first pepper cycle, in function of doses of the organic compound.




*Significant at 5% probability.
Source: Author Construction.

The application of organic fertilizer increases the organic matter present in the soil (BORCHARTT *et al*., 2011). In this way, the availability of these nutrients can meet the nutritional requirements of plants, contributing to improving the soil's water retention capacity, reducing irrigation frequency and producer spending (SILVA *et al.,* 2016).

The application of organic fertilizers to vegetables promotes increased productivity and quality of fruits, being recommended for soils with low organic matter content (Table1), because provide improvements in the physical-chemical characteristics that enhance rooting, enabling better reactions to stress caused by water deficit and attacks by pests and diseases. Therefore, the use of organic matter for pepper cultivation is recommended, especially for cultivation in pots, as it enhances and establishes productivity and fruit quality greater (FILGUEIRA, 2000).

According to Ziech *et al*. (2014), organic fertilizer originating from organic compounds, used in vegetable cultivation, has provided satisfactory results. This occurs due to various benefits of organic matter for production, such improving the soil physical and biological characteristics and increasing nutrients availability.

According to the Resume of analysis of variance (Table 4), for the second cultivation cycle, there was no significant effect of the organic compound for the analyzed variables.

**Table 4 -** Resume of analysis of variance, in the second cultivation cycle for plant height (PH), number of leaves (NL), number of fruits per plant (NFP), stem diameter (SD), root length (RL), root volume (RV), aerial fresh mass (AFM), fruit fresh mass (FFM) and productivity (PD) of pepper in response the application of organic compound.

| Variation sources | p-value <0,05 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | PH | NL | NFP | SD | RL | RV | AFM | FFM | PD |
| | -cm- | | | -mm- | --cm-- | --cm$^3$-- | -----g planta$^{-1}$----- | | kg ha$^{-1}$ |
| Organic compound | 0.61$^{ns}$ | 0.94$^{ns}$ | 0.37$^{ns}$ | 0.15$^{ns}$ | 0.40$^{ns}$ | 0.34$^{ns}$ | 0.69$^{ns}$ | 0.15$^{ns}$ | 0.15$^{ns}$ |
| CV(%) | 13.73 | 18.25 | 23.53 | 6.87 | 13.95 | 32.92 | 14.08 | 8.32 | 8.32 |

$^*$Significant at the level of 5%; $^{ns}$Not significant by F-test. CV - Coefficient of variation.
Source: Author Construction.

The low persistence of the soil organic compound may explain these results (SZAJDAK *et al*., 2003). This occurs because the compound has high mineralization rate, resulting in reduction in its influence on crops after the first cycle (SZAJDAK et al., 2003). According Santos *et al*. (1994), low residual effect of the organic compound limits its ability to benefit crops in subsequent cycles.

According to Moura *et al*. (2020), one main challenges for efficiency of fertilization with organic compounds is the need to synchronize the mineralization period of the fertilizer with the pepper cultivation cycle. The persistence of residual effect perform a crucial function in organic production systems, especially to facilitate successive crops. This reduces production costs, since the acquisition of inputs is limited by producers resources.

Given this, low residual effect of the organic compound on pepper growth and production may present additional challenges in such systems, given the need to obtain sustainable results over time.

## CONCLUSIONS

The organic compound provided improvement in the growth and production of pepper, in the first cultivation cycle, with a dose of 12 kg m$^{-2}$ being recommended.

The organic compost increased soil organic matter values in the first crop cycle.

The organic compound did not influence the growth and production of pepper in the second cultivation cycle, requiring additional fertilization.

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