Organic fertilization affecting pests and production of Lippia sidoides Cham. (Verbenacea)

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ABSTRACT: The objective of this paper was to study the effect of four levels of organic fertilization (0, 3, 6 and 9 kg m-2) to produce the essential oil of Lippia sidoides Cham. (Verbenacea) and its pests. A higher number of red mite Tetranychus sp. (Acari: Tetranychiidae) was observed on the abaxial face of the median and basal leaves of L. sidoides plants with eight weeks of age cultivated with 6 kg m-2 of organic fertilization. On the other hand, the smallest number of this mite was noted in control (0 kg m-2). L. sidoides cultivated with 6 kg m-2 of organic fertilization produced a greater quantity of essential oil. The highest number of mealy bug Phenacoccus sp. (Hemiptera: Pseudococcidae) was observed on the apical leaves (both leaf surfaces) of L. sidoides plants with nine and ten weeks of age cultivated with 3 kg m-2 of organic fertilization. No significant effect of the organic fertilization on Aphis gossypii Glover (Hemiptera: Aphididae) was detected. However, a greater number of this aphid and of its predator Scymnus sp. (Coleoptera: Coccinelidae) was observed on the abaxial face of the bottom leaves of L. sidoides plants with eight weeks of age. The dose of organic fertilization recommended for the production of essential oil of L. Sidoides is 6 kg m-2, however, one must pay attention to the fact this dosage favors the attack by Tetranychus sp.. And, when needed, pulverization must always be directed to the lower surface of the leaf.

Keywords: medicinal plants, insects, mites, family farm, competition

RESUMO: Adubação orgânica afetando a ocorrência de pragas e a produção de Óleo essencial em Lippia sidoides Cham. (Verbenacea). O objetivo deste trabalho foi avaliar o efeito de quatro níveis de adubação orgânica (0, 3, 6, e 9 kg m-2) na produção de óleo essencial de Lippia sidoides Cham. (Verbenacea) e de suas pragas. Observou-se maior número de ácaro vermelho Tetranychus sp. (Acari: Tetranychiidae) na face inferior das folhas dos terços medianos e basais das plantas de L. sidoides com oito semanas de idade cultivadas com 6 kg m-2 de adubo orgânico. Por outro lado, a menor quantidade deste ácaro foi notada na testemunha (0 kg m-2). L. sidoides cultivada com 6 kg m-2 de adubo orgânico produziu maior quantidade de óleo essencial. Observou-se maior número de cochonilhas Phenacoccus sp. (Hemiptera: Pseudococcidae) nas folhas apicais, sem distinção de face foliar, das plantas de L. sidoides com nove e 10 semanas de idade cultivadas com 3 kg m-2 de adubo orgânico. Não se detectou efeito significativo de adubo orgânico sobre Aphis gossypii Glover (Hemiptera: Aphididae). Contudo, observou-se maior número desse pulgão bem como de seu predador Scymnus sp. (Coleoptera: Coccinelidae) nas faces abaxiais das folhas basais das plantas de L. sidoides com oito semanas de idade. A dose de adubo orgânico recomendada para produção de óleo essencial de L. sidoides é de 6 kg m-2. Contudo, essa dosagem favorece o ataque de Tetranychus sp. e, quando necessário, deve-se dirigir a pulverização sempre para a face inferior da folha, local preferencial de ataque dos artrópodes.

Palavras-chave: plantas medicinais, insetos, ácaros, agricultura familiar, competição

INTRODUCTION

Lippia sidoides Cham. (Verbenacea) is originally from Brazil, and its propagation is obtained by cutting or air layering. Its main chemical constituents are essential oils, containing more than 60% of thymol or a mixture of thymol and cavacrol, with antimicrobial action against throat infections, dental caries, impingens, acne, ulcers, scabies, dandruff, bad smells of feet and armpits, mange

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infections and athlete's foot, and antispasmodic (Martins *et al.*, 1994; Lorenzi & Matos, 2002). The compounds tectol and lipsidoquinone exhibit significant activity against human leukemic cells (Costa *et al.*, 2001; Carvalho *et al.*, 2003; Girão *et al.*, 2003). In dogs, the essential oil of this plant reduces marginal gingivitis caused by bacteria, and shows larvicidal activity against *Aedes aegypti* L. (Diptera: Culicidae) (Carvalho *et al.*, 2003; Girão *et al.*, 2003).

Medicinal plants are an interesting and profitable alternative for Brazilian agriculture (Simões *et al.*, 2000). Therefore, it is necessary to study the nutritional requirements of the plant to commercial crops (Silva *et al.*, 2009). For the cultivation of medicinal plants, such as *L. sidoides*, is recommended the use of organic fertilization to improve the physical and biological properties of soil, correcting possible deficiencies of macro and micronutrients in soil and can reduce the attack of insect herbivores (Primavesi, 1988; Martins *et al.*, 1994; Sartório *et al.*, 2000; Leite *et al.*, 2006). However, the excess of organic fertilization can also promote the attack of insects in medicinal plants (Leite *et al.*, 2005). Silva *et al.* (2009) verified that the omission of nutrients affected the attack of insects in *L. sidoides*.

The species of medicinal plants usually show resistance to attack by diseases and pests (Leite *et al.*, 2006). But for some non-balance, there may be attacks of pests and diseases harmful levels to these species of plants (Leite *et al.*, 2005; Silva *et al.*, 2009). Thus, nutrition (food factor) is very important in the distribution (spatial and temporal) and abundance of insects, directly or indirectly influencing the population of insects in biological, morphological and behavioral processes (Dent, 1995; Gallo *et al.*, 2002).

Thus, the objective of this paper was to study the effect of organic fertilization to produce the essential oil of *L. Sidoides* and its pests and the spatial and temporal distribution of these pests.

MATERIAL AND METHOD

Lippia sidoides exsiccates (dried specimens) is in the Federal University of Juiz de Fora. The experiment was carried out at in the "Instituto de Ciências Agrárias da Universidade Federal de Minas Gerais" from June to November 2006, in greenhouse conditions. The soil used was a dystrophic red yellow latosol alico, collected in the layer of 0-20 cm of depth (Embrapa, 1999) in savanna vegetation placed in the municipality of Montes Claros, Minas Gerais State, Brazil, with the following attributes, as determined Embrapa (1997): pH in water 4.1, phosphorus 1 mg dm^{-3}, calcium 2 mmolc dm^{-3}, magnesium 1 mmolc dm^{-3}, potassium 0.5 mmolc dm^{-3}, aluminum 20 mmolc dm^{-3}, H+Al 100 mmolc dm^{-3}, zinc 0.3 mg dm^{-3}, manganese 2 mg dm^{-3}, iron 6 mg dm^{-3}, cuprum 0.1 mg dm^{-3}, boron 0.1 mg dm^{-3}, organic matter 20 g kg^{-1}, sand 500 g kg^{-1}, silt 80 g kg^{-1} and clay 420 g kg^{-1}.

The experimental design was completely casual with seven repetitions, with each repetition consisted of two plants/pot. The seedlings were produced by cutting in commercial substrate (vermiculite) in rooting bed under controlled humidity. After rooting, about 45 days, the seedlings were transferred to pots with 3 dm^3 of soil, with assessments beginning next month. The treatments were the following levels of organic fertilization: 0, 3, 6 and 9 kg/m^2 of manure from cow tanned. The irrigation was made with distilled water in order to avoid the contamination and to commit the influence of the fertilization.

Weekly, in the morning part, we evaluated (visual inspection) the numbers of arthropods, in both the leaf faces, on the bottom, middle and apical parts of each plant (three leaves per plant) in two plants/pot (Silva *et al.*, 2009) as well as their damages. Insects were collected, using an aspirator or tweezers, and held individually, in 8x2 cm glass flasks containing 70% ethanol, for identification.

The plants were harvested after 90 days of the cuttings were planted. Then samples of fresh material were used to determine the level of essential oil, by hydrodistillation, using Clevenger equipment (Figueiredo *et al.*, 2009; Melo *et al.*, 2011). The aerial part was fragmented, weighed, the sample of approximately 100 g of the plant, placed in a glass flask with distilled water (Figueiredo *et al.*, 2009; Melo *et al.*, 2011). The extraction process was conducted for four hours. After this period of time, the product resulting from the extraction was submitted to a drying process in a forced air circulation chamber for the determination of the dry matter sample (60ºC, to constant weight) (Figueiredo *et al.*, 2009; Melo *et al.*, 2011). The content of essential oil was estimated based on the dry material (g of oil $100g^{-1}$ of dry material) (Figueiredo *et al.*, 2009; Melo *et al.*, 2011).

The collected data were submitted to statistical analysis and to the tests Tukey to 5% of probability.

RESULT AND DISCUSSION

The higher number of red mite *Tetranychus* sp. (Acari: Tetranychiidae) was observed on the abaxial face of the median and basal leaves of *L. sidoides* plants with eight weeks of age cultivated with 6 kg m^{-2} of organic fertilization (Figures 1-4), resulting in numerous chlorotic spots in the leaves, and consequently, reducing their capacity to realize photosynthetic, as observe by Silva *et al.* (2009). On the other hand, the smaller number of this mite

was noted in control (0 kg m^{-2}) (Figure 1). Silva *et al.* (2009) observed higher attack and damage of red mite *Tetranychus* sp. in *L. sidoides* seedlings whose soil had not received fertilization of phosphorus (low phosphorus), but had received supplies of nitrogen. Plants with phosphorus deficiency can block protein synthesis resulting in accumulation of free aminoacids (Marschner, 1995), providing better nutrition for arthropods (Chaboussou, 1999; Gallo *et al.*, 2002). Another possible explanation for the largest attack of *Tetranychus* sp in *L. sidoides* plants cultivated with 6 kg m^{-2} of organic fertilization is that this same fertilizing was observed the largest producer of essential oils (Figure 5), perhaps these are factors of susceptibility to this mite, increasing its attack. Leite *et al.* (2005) studying the same range of doses of organic fertilization that this work, also observed increased for quantity production (number of capitulum $plant^{-1}$) and quality (tenor of total flavonoids) of *Calendula officinalis* L. with 6 kg m^{-2} as well as the greater attack of aphids *Uroleucon ambrosiae* f. *lizerianum* (Hemiptera: Aphididae) on plants fertilized with 6 and 9 kg m^{-2} organic fertilization. Silva *et al.* (2009) also noted that the red mite preferred to attack the same parts of the *L.*

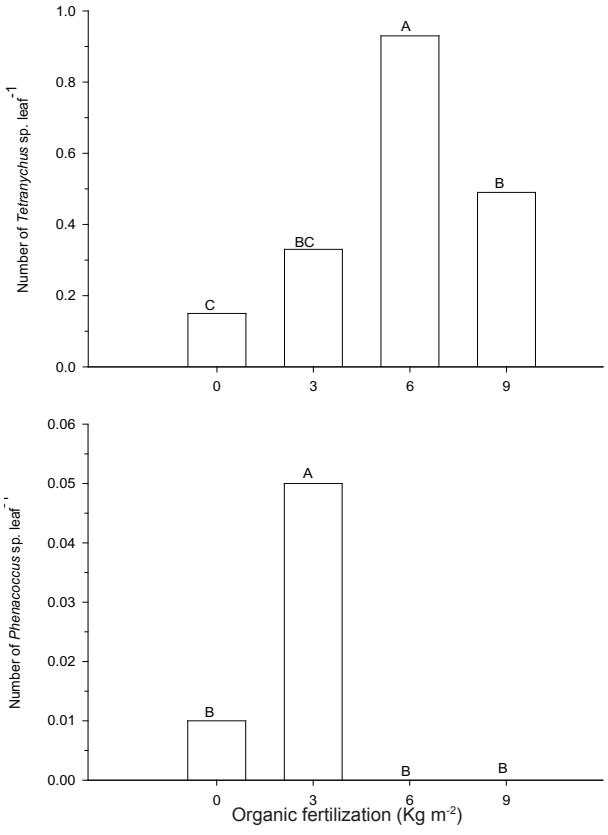

FIGURE 1. Effect of organic fertilization in the number of *Tetranychus* sp. and *Phenacoccus* sp. $leaf^{-1}$ of *Lippia sidoides*. Means with different letter differ at $p < 0.05$ (Tukey).

sidoides plants with 90 days of age.

The higher number of mealy bug *Phenacoccus* sp. (Hemiptera: Pseudococcidae) was observed on the apical leaves (both leaf surfaces) of *L. sidoides* plants with nine and ten weeks of age cultivated with 3 kg m^{-2} of organic fertilization (Figures 1, 2 e 4), resulting in the formation of sooty mold on leaves, coming fungal attack on the substrate formed by the sugary liquid removed by this insect, as a result of suction sap of plants, as observed by Silva *et al.* (2009). Silva *et al.* (2009) reported greater attack of *Phenacoccus* sp. in *L. sidoides* seedlings whose soil did not received calcium (low tenor) but had been fertilized with N. The Ca participant's cell wall synthesis and lignin (Taiz & Zeiger, 2004), and induction of plant resistance to attack by sucking insects (Correa *et al.*, 2005; Gomes *et al.*, 2005). On the other words, the plants, probably, had more free aminoacid and cell wall more weak, favoring the attack of *Phenacoccus* sp. Silva *et al.* (2009) also observed that *Phenacoccus* sp. preferred to attack the abaxial face of apical part of *L. sidoides* plants at the end of the experiment (120 days). A possible explanation for the largest attack of *Phenacoccus* sp. in plants fertilized with 3 kg m^{-2} of organic fertilization is the possibility of an antibiotic or non-preference effects of *L. sidoides* essential oils on this insect in higher doses of organic fertilization (Figure 5). Medicinal plants, in general, are less attacked by insects because of their chemical compounds (Leite *et al.*, 2006).

No significant effect was detected between organic fertilization and *Aphis gossypii* Glover (Hemiptera: Aphididae). However, the greater number of this aphids and its predator *Scymnus* sp. (Coleoptera: Coccinelidae) was noted on the abaxial face of the bottom leaves of *L. sidoides* plants with eight weeks of age. (Figuras 2-4), similar fact also observed by Silva *et al.* (2009) in seedlings of this plant.

Interesting to note the spatial and temporal distribution of *Tetranychus* sp., *Phenacoccus* sp. and *Aphis gossypii* on plants of *L. sidoides*, because of this work as well as Silva *et al.* (2009), these pests maintained a certain standard among them. In general, what is observed are colonization niches, because *Tetranychus* sp. has occupied the median or basal part of plants, alternating with *A. gossypii*, since that both the pests attacked plants almost the same time, and *Phenacoccus* sp. colonized the apical part of plants and more the end of *L. sidoides* cultivation (Figures 2 and 4) (Silva *et al.*, 2009). Thus, maybe these pests avoid a direct competition between them, as observed for aphids (Vehrs *et al.*, 1992).

Another factor that may be affecting the temporal distribution these arthropods is the

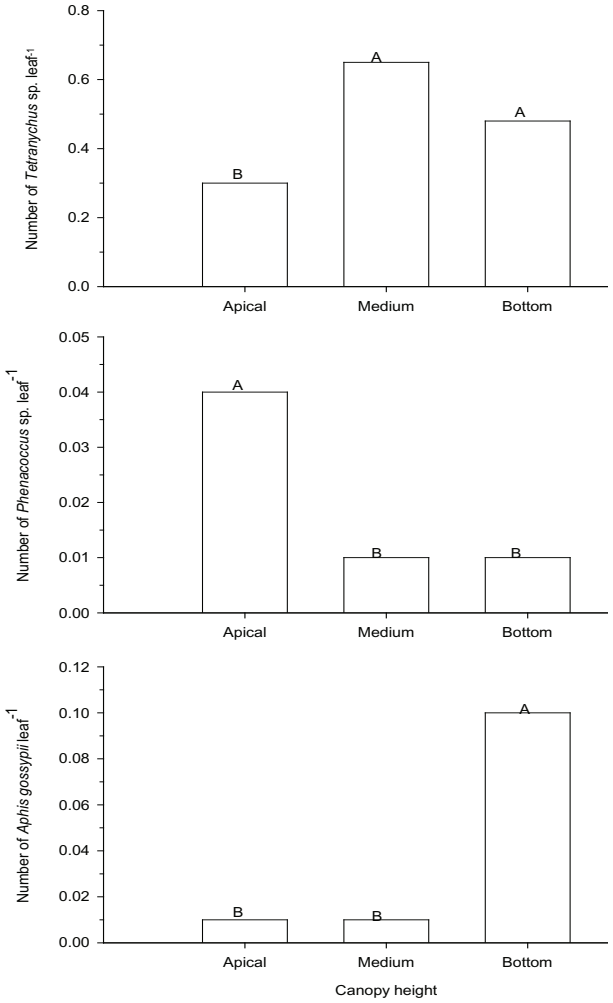

FIGURE 2. Effect of canopy height in the number of *Tetranychus* sp., *Phenacoccus* sp. and *Aphis gossypii* leaf^{-1} of *Lippia sidoides*. Means with different letter differ at p< 0.05 (Tukey).

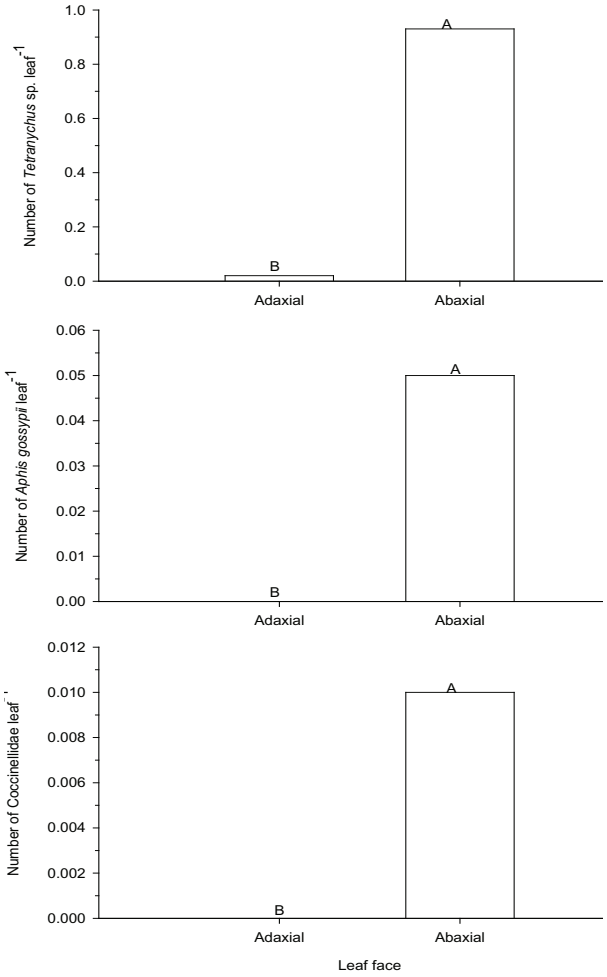

FIGURE 3. Effect of leaf face in the number of *Tetranychus* sp., *Aphis gossypii* and Coccinellidae leaf^{-1} of *Lippia sidoides*. Means with different letter differ at p < 0.05 (Tukey).

variation of essential oils concentration with the aging plant. Figueiredo *et al.* (2009) collected the *L. sidoides* at 120, 180, 240, 300 and 360 days after transplanting and observed increased production of essential oils to 180 days. In this study, seedlings of this plant was studied, but we can suggest, noting the results of Figueiredo *et al.* (2009), that the highest concentration of essential oil occurred in seedlings with 10 weeks of age, which explains the largest attack of *Phenacoccus* sp. and smallest of *Tetranychus* sp. and *A. gossypii*. In other words, *Phenacoccus* sp. is less affected negatively or positively affected by essential oils of *L. sidoides*, the opposite occurred with the two other arthropods. Thinking in this line of reasoning, in general, the apical leaves has greater density of glandular trichomes as well as higher quantity of intact trichomes (less broken) than the basal leaves (Leite *et al.*, 1999), which may explain why *A. gossypii* and *Tetranychus* sp. preferentially attacked the middle and basal leaves of *L. sidoides* seedlings, the opposite occurred with the *Phenacoccus* sp..

Therefore, it is necessary to know qualitatively and quantitatively the chemical constituents of a plant during its growth (Leite *et al.*, 2001; Figueiredo *et al.*, 2009) as well as over its canopy (Leite *et al.*, 1999). Because these factors may be affecting the colonization of *L. sidoides* by herbivores as it has low capacity to host arthropods (Leite et al., 2006), probably due to deleterious effects on these pests (Carvalho *et al.*, 2003; Santiago *et al.*, 2008).

We observed that increasing the dose of organic fertilization increased fresh and dry weight and essential oil (mL), but the higher production of essential oil per dry weight was observed around 6 kg m^{-2} (Figure 5). Souza *et al.* (2010) noted higher production of essential oil production (fresh or dry

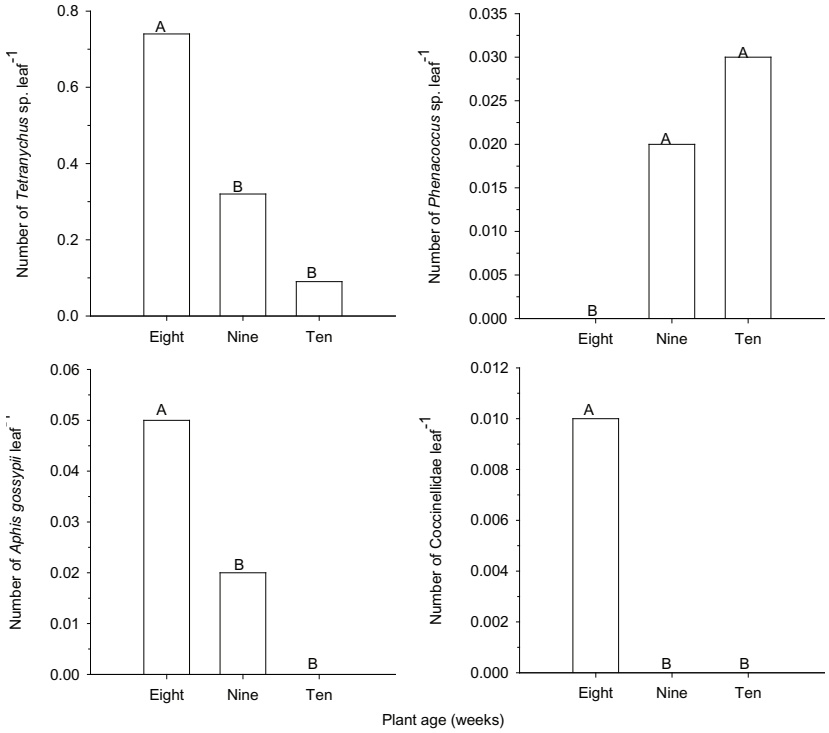

FIGURE 4. Effect of plant age in the number of *Tetranychus* sp., *Phenacoccus* sp., *Aphis gossypii* and Coccinellidae leaf^{-1} of *Lippia sidoides*. Means with different letter differ at p< 0.05 (Tukey).

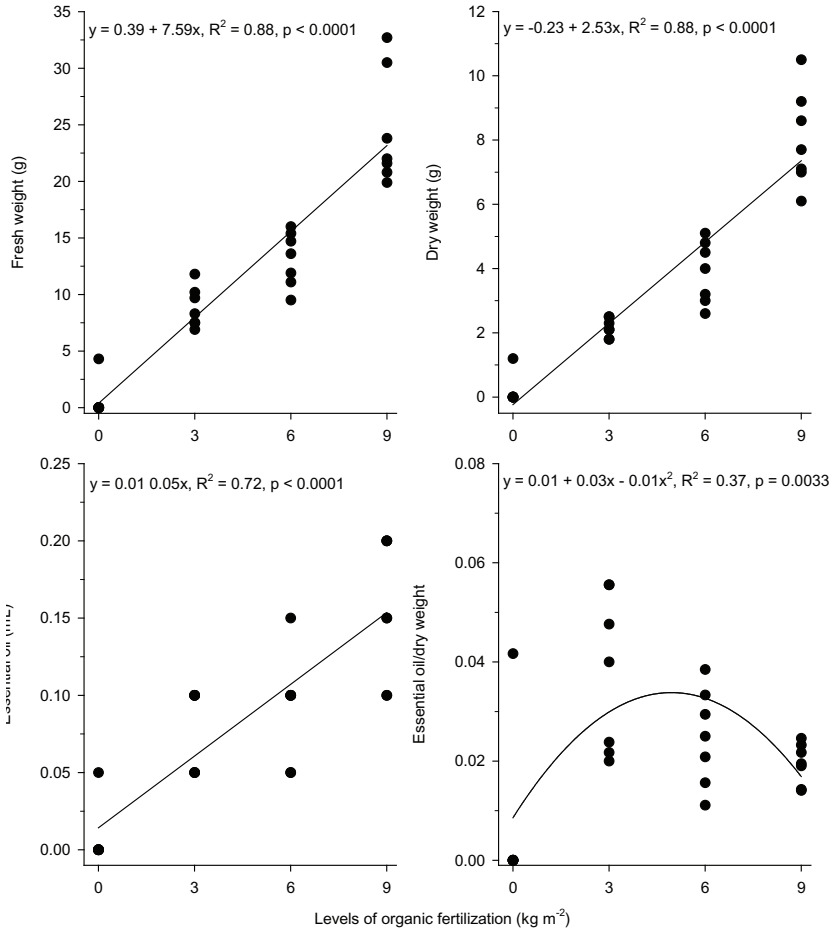

FIGURE 5. Effect of four levels of organic fertilization (0, 3, 6 and 9 kg m^{-2}) on production of fresch and dry weight (g), essential oil, and essential oil/dry weight by *Lippia sidoides* Cham.

matter) in *Lippia citriodora* Kunth under treatments with bovine manure (32 t ha^{-1}). *Lippia sidoides* produce great quantity of essential oil content at 180 days after transplanting (Figueiredo *et al.*, 2009).

In summary, the dose of organic fertilization recommended for production of essential oil of *L. Sidoides* is 6 kg m^{-2}, however one must be attentive the attack of *Tetranychus sp.*, as this dosage favors them.

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