English Version

Residues of cattle slaughterhouse effluent as an alternative fertilizer for the production of rocket

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Abstract

The use of high doses of mineral fertilizers recommended for growing vegetables, besides burdening the production process, triggers the environmental imbalance. Thus, the demand for information which enables the use of different waste materials as organic fertilizers has been increasing. Therefore, the objective was to evaluate the effect of rates of residual waste of effluent treatment on morphophysiological income of *Eruca sativa* L. in central southern region of the state of Tocantins. The experiment was performed with the culture of the rocket, underwent five treatments that consisted of five doses of the residue (0, 20, 40, 60, and 80 Mg ha^{-1}) and three replications. The characteristics evaluated were: total dry matter (g), leaf number, leaf area (cm^2) and net assimilation rate. For every characteristic, samples were collected for analysis at 10, 15, 20, 25, 30 and 35 days after sowing. For all traits there was positive effect of the residual dose, responding to higher doses (60 and 80 Mg ha^{-1}). The use of refrigerated beef residue as an alternative fertilizer promoted the development of the rocket with an increase in production until the dose of 80 Mg ha^{-1}.

Key words: *Eruca sativa* L. growth analysis; organic residues

Introduction

The organic fertilization with animal manure and organic compounds has been widely used in the production of vegetables with the objective of reducing the quantity of chemical fertilizer and improve the physical, chemical and biological qualities of the soil (SILVA et al., 2001).

According to MELO and MARQUES (2000), the organic waste generated by human and industrial activities may be used as source of nutrients to plants and as soil conditioners, and have been a viable alternative in the preservation of the environmental quality.

Due to this fact, the use of alternative products have increased, which raised their demand in the Brazilian agriculture, and together the search for less aggressive inputs to the environment and which enable the development of an agriculture less dependent on the industrialized products (MEDEIROS et al., 2007).

The residue of effluent treatment tanks generated in cattle slaughterhouse (RCS), due to its chemical composition, is an alternative of organic compound to the vegetal fertilization. According to MELLO and VITTI (2002), the organic matter which compounds the residue may cause significant effects in the pH and cation exchange capacity, improving the productive capacity of soil.

SOMMERS (1977) affirms that these residues may have considerable contents of N, P and C and practically all the micronutrients. The author also reports that their use increases the cation exchange capacity (CEC), the soil porosity and aeration, providing higher volume of available water. KIEHL (1985) already discarded the preoccupation with high content of heavy metals in cattle residues.

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et al. (2003) it was verified that the application of brewery sludge in the lettuce culture provided significant increase in the dry matter of shoot and also in the content of phosphorus and in the values of pH of the soil, with effects similar to those obtained with poultry manure.

Rocket (*Eruca sativa* L) is a leaf vegetable noteworthy for its composition specially for presenting relatively high levels of potassium, sulfur, iron, vitamins A and C and by having piquant flavor, characteristic and agreeable smell. It still has substances important to maintain health, besides being high in omega 3 (FILGUEIRA, 2000). Despite being a vegetable well consumed, the culture still has a lack of studies which demonstrate alternatives to the cultivation, especially concerning nutrition and fertilization.

Considering these aspects, the objective of the work was to evaluate the effect of doses of residue produced in effluent treatment tank generated with the cattle slaughter over the growth of rocket plants in the south center region of the state of Tocantins.

Material and methods

The experiment was conducted in the experimental area of the Federal University of Tocantins (Universidade Federal de Tocantins – UFT), University Campus of Gurupi, located in the south center region of the state of Tocantins in the year 2008. The climate classification according to KÖPPEN (1948) characterizes the region as type B1wA'a', humid with moderated water deficiency. It presents altitude of 280 m, the annual average temperature is 29,5 °C, with average annual rainfall of 1,804 mm.

The experiment was conducted in randomized blocks design with three replications. The experimental unit was composed by 100 plants distributed in beds with one meter of length. The seeding was performed in the already fertilized beds in five rows cross cutting the length of the beds, leaving after the thinning a space of 0.25 x 0.50 m between rows and between plants inside the row, respectively. It was used as useful parcel the plant of the three center rows.

The soil used in the experiment presented the following characteristics: pH (H_20) – 5.0; Organic Matter – 0.9%; Calcium – 0. 78 g dm^{-3}; Magnesium – 0.078 g dm^{-3}; Aluminum – 0.43 g_c dm^{-3}; Hydrogen + Aluminum – 1.63 g dm^{-3}; Potassium – 12.1 mg dm^{-3}; Phosphorus – 1.7 mg dm^{-3}. The residues used came from the effluents treatment system of cattle slaughterhouses of the COOPERFRIGU - Cooperativa dos Produtores de Carne e Derivados de Gurupi (TO) (Meat and Derivatives Producers Cooperative from Gurupi) and presented: pH ($CaCl_2$) – 5.9; Organic Matter – 14%; Nitrogen: 1.22 g dm^{-3}; Calcium – 1.75 g dm^{-3}; Magnesium – 0,47 g dm^{-3}; Aluminum – 0.0 g dm^{-3}; Hydrogen + Aluminum – 0.97 g dm^{-3}; Potassium – 206 mg dm^{-3}; Phosphorus– 810 mg dm^{-3}.

The treatments consisted in increasing doses of residue produced in effluent treatment tanks generated in cattle slaughterhouse (RCS) (0; 20; 40; 60 and 80 Mg ha^{-1} equivalent to 0; 41.89; 83.78; 125.67; 167.56 kg ha^{-1} N). The analysis of growth was performed from plant sampling during the culture cycle, in six evaluation periods, which were: 10, 15, 20, 25, 30 and 35 days after planting (DAP). It was collected nine plants in each treatment per sampling.

The leaf area was estimated by the method of BLACKMAN and WILSON (1951). In each plant sampling it was evaluated the following characteristics: leaf dry matter, number of leaves, leaf area. Trough these data, it was obtained the net assimilation rate, according to the description of RADFORD (1967).

With the values obtained from the replications to the variable, data was submitted to the analysis of variance (F test) and the equations of regression were adjusted, using the software Sisvar.

Results and discussion

There was effect of the increase in the dose of RCS in the production of rocket dry matter (Figure 1). In general, the production of dry matter presented linear behavior in function of the applied dose. An exception was observed when there was application in the doses of 60 and 80 Mg ha^{-1} in the periods of 10 and 15 DAP, which did not present a linear response, and may be explained by the high doses of RCS applied, which probably promoted the elevation of the values of electrical conductibility and/

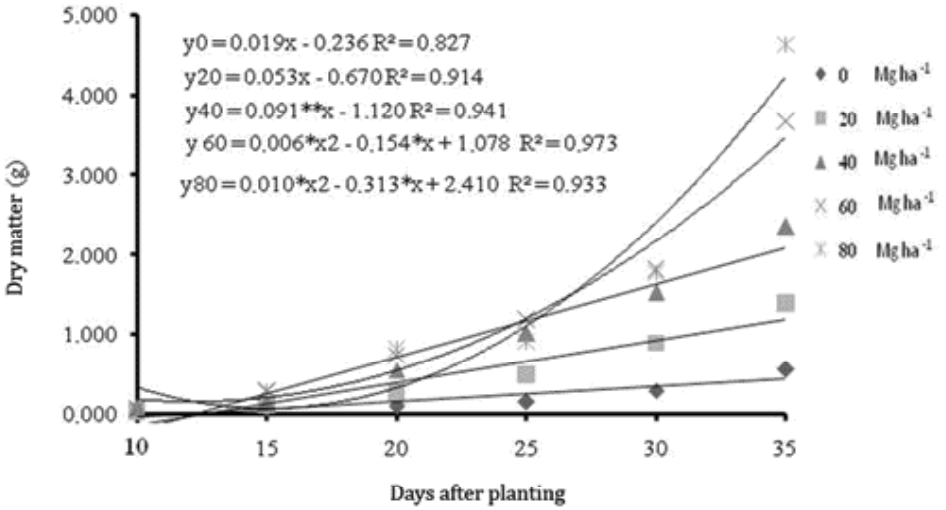

Figure 1. Effect of the fertilization with cattle slaughterhouse residue in the accumulation of dry matter of the culture of rocket (*Eruca sativa* L.).

or production of ammonia in excess.

In the treatment without application of RCS, it was verified the lower production of dry matter, ranging from 0.023 g 10 DAP to 0.55 g 35 DAPS (Figure1). Concerning this behavior, FILGUEIRA (2000) reports that the culture is demanding in soil nutrients, mainly nitrogen and phosphorus. In the superior doses of RCS (40; 60 and 80 Mg ha^{-1}), there was a satisfactory increase in the production of dry matter, due to the higher availability of these nutrients to the culture.

The doses of 20 Mg ha^{-1} also did not influence in the culture development, providing an accumulation of dry matter which ranged from 0.03 g 10 DAP to 1.38 g 35 DAP (Figure 1). Plants submitted to doses of 60 Mg ha^{-1} and 80 Mg ha^{-1} were different, presenting accumulation of 3.66 g and 4.63 g, respectively, 35 DAP when the rocket was in the commercial stage. In these doses, there was higher plant growth, which might have happened due to the input and availability of nutrients present in this residue.

The management of the organic matter in a rocket production system is essential, since it is one of the main sources and reserve of N and responds for great part of the CEC of the soil, which in tropical soils may correspond to values which range from 56 to 82% (RAIJ, 1969). In this aspect, the residue acts over the physical properties of the soil, conditioned mainly by the presence of organic matter, being noteworthy the improvement in the state of aggregation of the soil particles, with consequent decrease in density and increase in the aeration and retention of water (MELO e MARQUES, 2000). It was observed in the higher doses of the residue of cattle slaughterhouse higher response of plants in production of dry matter, possibly due to the improvement in the physical and chemical conditions of the soil. Concerning chemical aspects, the application of the residue to the soil has provided elevation of the contents of phosphorus (SILVA et al., 2002), organic carbon (CAVALLARO et al., 1993), humin fraction of the organic matter (MELO et al., 1994), pH, electric conductivity and cation exchange capacity (OLIVEIRA et al., 2002).

Concerning number of leaves, the linear regression was the one that explained best the variation of this characteristic in function of the RCS doses used. With an exception of the dose of 40 Mg ha^{-1}, which had a behavior that was better adjusted to a quadratic equation, showing that there was a reduction on the number of leaves in the end of the cycle (Figure 2). In a general way, it was observed that the higher doses of slaughterhouse residues, i.e., 60 and 80 Mg ha^{-1}, provided similar results in the

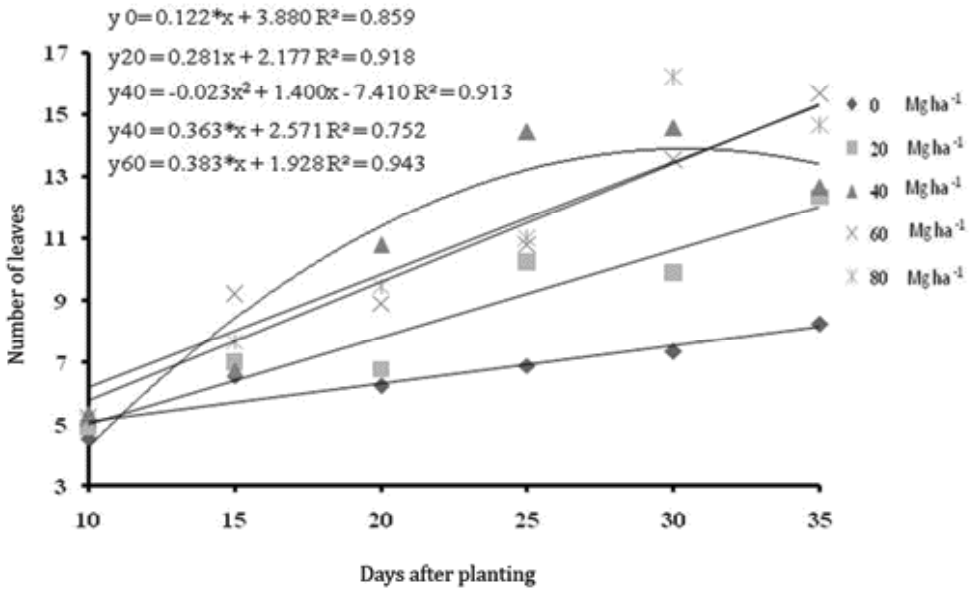

Figure 2. Effect of the fertilization with cattle slaughterhouse residue in the number of leaves of the Rocket (*Eruca sativa* L..) culture.

increase of the number of leaves along the culture cycle, fact explained by the higher availability of soil nutrients due to the higher dosage of fertilizer used.

According to TRANI et al. (1996), the recommendation of nitrogen for the rocket culture is 160 kg ha^{-1}. It may be observed that the dose of 80 Mg ha^{-1} corresponds to approximately the recommendation of nitrogen to the culture (167.56 kg ha^{-1} N), supporting the observed results. When it was used 80 Mg ha^{-1} equivalent to 125.67 kg ha^{-1}, it was observed that there was no similarity in relation to the highest concentration of the residue in all the variables evaluated. This might have occurred not only due to the nutritional composition of the residue, but also to the influence on the improvement of the physical characteristics, reflecting in the increase of production of dry matter of plants and contributing positively to increase the productive capacity of the plants.

In the treatment which did not receive any dose, it was observed a low increase in the number of leaves between the collections along the culture cycle (Figure 2). This result may confirm the influence of the residue on the number of leaves. OLIVEIRA et al. (2007) found in lettuce significant increase in the number of leaves per plant in response to the increase in the in the recommended dose of organic fertilizer. CAVALLARO JÚNIOR et al. (2009) also studying alternative sources of fertilizers to the rocket culture observed positive effect of the organic fertilization in the culture production. LINHARES et al. (2008), analyzing the best dose of green fertilizer (*Ipomoea glabra* L.) incorporated to the soil as an alternative source of fertilizer observed that all the characteristics were influenced with the incorporation of jitirana in the production of rocket.

The increase in the leaf area of rocket plants presented linear behavior with the increase in the RCS doses in the different evaluation periods, with exception of the dose of 20 Mg ha^{-1} (Figure 3).

The best result was observed with the highest dose of the residue in most of the samples. However, independent on the recommended dose, the seedlings presented a slow development in all the dosed, this fact may be explained either by the natural initial growth of vegetables (Barros Júnior et al., 2009), or by the lower initial liberation of nutrients to the culture after their incorporation in the bed soil. Thus, the use of RCS, as well as the use of manure

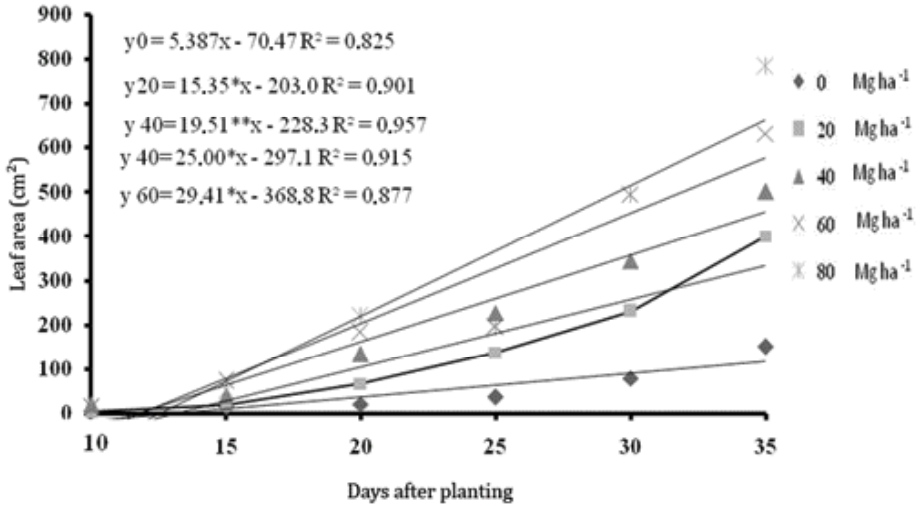

Figure 3. Effect of the fertilization with cattle slaughterhouse residue in the leaf area of the Rocket (*Eruca sativa* L.) culture.

also requires a time of incorporation in the soil. This is necessary so that there is an advance in the process of mineralization, avoiding a possible initial immobilization of nutrients coincident with the culture planting.

In the present work, even considering that the used residue came from a process of accumulation of several years, and, therefore, it was expected an advanced state of mineralization, it was possible the mixture with new sedimented material still in natura.

The net assimilation rate provides an estimative of net photosynthesis per unit of photosynthetically active tissue, corresponding to the final balance between the leaf photosynthesis, the respiratory consumption and the absorption of mineral nutrients FRANÇA et al. (2008). About this aspect, the highest net assimilation rate was observed 10 DAE (0.0021 g cm^{-2} day^{-1}), which

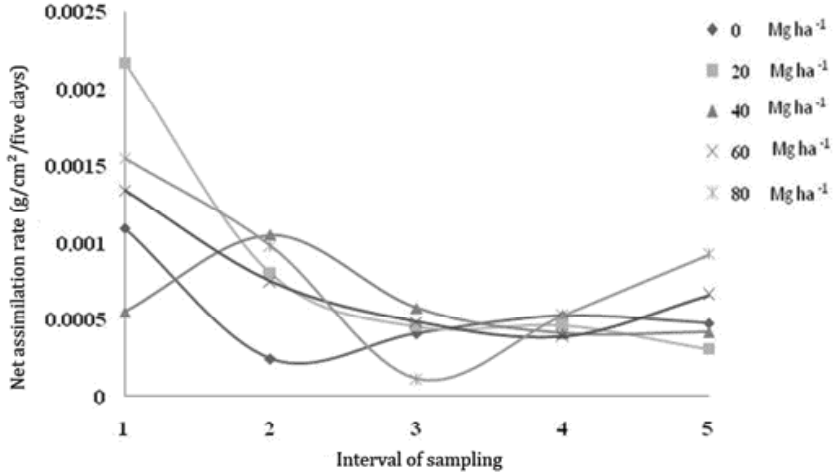

Figure 04. Net assimilation rate of the rocket (*Eruca sativa* L.) culture fertilized with cattle slaughterhouse residue in Gurupi – TO.

correspond to the dose of 20 Mg ha^{-1} of the residue (Figure 4).

It was observed a light decrease on the net assimilation rate along the evaluation periods with the application of all the RCS doses used. This behavior is explained due to the self-shading, however in the lest periods of evaluation, the net assimilation rate tended to increase possibly due to the increase on the availability of nutrients in the soil solution which indirectly favors the performance of the plant photosynthesis. This may have contributed to the improvement of the architecture of the plant, which normally in rocket tend to have a more vertical position, especially to new leaves when indicated the point of harvest. Thus, it might be considered a viable possibility of use of RCS to substitute the mineral fertilization in the rocket cultivation.

Conclusion

Since rocket is a vegetable normally cultivated by small producers, the use of RCS may be an important alternative of fertilization and soil conditioner, once it was possible to verify favorable response to all the evaluated characteristics.

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