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Cabbage production in function of castor bean cake doses in top dressing

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Abstract

The researches with organic fertilization in top dressing in production of vegetables are rare, thereby, the objective of this study was to evaluate castor bean cake doses in top dressing in cabbage production. Seven treatments, six castor bean cake doses in top dressing (0; 50; 100; 150; 200 and 250 g m^{-2}) and an inorganic control with ammonium sulphate (11.5 g m^{-2} of N) and potassium chloride (5.4 g m^{-2} of K_2O) in top dressing were evaluated, in randomized blocks experimental design, with five replicates. Before planting it was made fertilization with organic compost (20 t ha^{-1}) and inorganic NPK fertilizer (4-14-8) (1 t ha^{-1}), only in inorganic control. The characteristics evaluated were: cabbage head diameter, height, number of leaves, fresh and dry weight of cabbage. The application of castor bean cake in top dressing increased the diameter, height, number of leaves, fresh and dry weight of cabbage, with maximum values of 164 mm, 109 mm, 30 leaves, 1470 g and 103 g, respectively. The average fresh and dry weight obtained in the two highest doses of castor bean cake did not differ from the inorganic control, proving the technical viability of its using. Therefore, it can be recommended application of at least 200 g m^{-2} of castor bean cake in top dressing for cabbage production.

Keywords: *Brassica oleracea* var. *capitata*, organic fertilization, vegetables

Introduction

In Brazil, cabbage is the most important vegetable of the Brassicaceae family, which includes cabbage, cauliflower, broccoli, kale, turnip, radish, among other species. Cabbage presents high content of vitamins (A, B1, B2, B6 and mainly C) and minerals (Ca, P, and S). It is also of great social importance, because it employs a large amount of labor and is mainly cultivated by family farmers (Filgueira, 2013).

As the whole plant is usually harvested, or most of the same, the cabbage is considered highly exhausting to the soil, so it is high demanding in nutrients, being the nitrogen (N) and the potassium (K) the most extracted (Aquino et al., 2009; Corrêa et al., 2013). Because these nutrients are easily leachable in the soil, generally the application of these is splitted, part in the planting and another in top dressing.

Some studies have shown the importance of nitrogen in top dressing to increase the production and quality of cabbage (Aquino et al., 2009; Moreira & Vidigal, 2011; Moreira et al., 2011), while for potassium, Corrêa et al. (2013) did not obtain difference of production with different doses and sources. All of these researches were performed with inorganic fertilization and, despite the increasing use of organic fertilizers, there are no reports of their use in cabbage in top dressing. Most of the researches in organic system are related to the use of organic fertilizers in the planting, not in top dressing.

Castor bean cake, produced during oil extraction, is an important byproduct of castor bean production chain. Its predominant use in agriculture is as organic fertilizer, since it is a rich source in nitrogen, with a faster release than most other organic fertilizers (Severino et al., 2004). Silva et al. (2016) reported that their use in top dressing increased beet production, being, depending on the dose, as efficient as inorganic fertilizers. However,

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Santos et al. (2012) did not find significant differences in onion production with different doses of castor bean cake in top dressing. In view of the exposed, the objective of this study was to evaluate the effect of the castor bean cake applied in top dressing in cabbage production.

Material and Methods

The experiment was conducted at the São Manuel Experimental Farm, in São Manuel-SP, belonging to the School of Agriculture (FCA) of the Sao Paulo State University (UNESP). The geographical coordinates are 22° 46' south latitude, 48° 34' west longitude and 740m altitude. According to the Köppen criteria, the climate of the municipality is classified as *cfa* (warm temperate), humid, with rains concentrated in the months of October to March, with an average annual rainfall of 1,377 mm (Cunha & Martins, 2009).

The soil where the experiment was installed is a sandy soil, classified as Typical Dystrophic Red Latosol. The chemical analysis (0-20 cm depth) resulted: $pH_{(CaCl2)}$ = 5.6; organic matter (OM) = 10 g m^{-3}; P = 195 mg dm^{-3}; H+Al = 16 $mmol_c$ dm^{-3}; K = 3.1 $mmol_c$ dm^{-3}; Ca = 27 $mmol_c$ dm^{-3}; Mg = 4 $mmol_c$ dm^{-3}; SB = 34 $mmol_c$ dm^{-3}, CEC = 50 $mmol_c$ dm^{-3} and V = 69 %. According to the soil analysis, it was applied 20 t ha^{-1} of organic compost (wet basis, with humidity of 30 %) in all area, and 1 t ha^{-1} of NPK (4 -14 - 8), only in the inorganic control.

Seven treatments were studied: six doses of castor bean cake (0; 50; 100; 150; 200; and 250 g m^{-2}) and one control with inorganic fertilization (IF) with ammonium sulfate (11.5 g m^{-2} of N) and potassium chloride (5.4 g m^{-2} K_2O) in top dressing, in the randomized block design, with five replicates.

The organic and inorganic fertilizers used in the planting were applied in the total area of the beds and later incorporated to a depth of 20 cm. In top dressing, the fertilizers were applied between lines, manually without incorporation. The total doses were divided in four splittings and the applications were made at 14, 28, 42 and 56 days after transplantation.

Castor bean cake from company Nutrisafra fertilizers was used. A chemical analysis of this cake indicated the values of OM; N; P_2O_5; K_2O; Ca; Mg and S, expressed as % in dry matter, respectively: 82; 4.79; 0.87; 0.99; 1.97; 1.08 and 0.27. The C/N ratio was 9, pH 6.04 and moisture content 9.03 %.

Hybrid Kenzan was used, and sowing was made on 04/13/2015 in 200 cell polypropylene trays containing substrate for vegetable. The seedlings were transplanted on 05/15/2015 for beds, with three lines in the longitudinal direction, spaced 0.40 m between lines and 0.60 m between plants. Each plot consisted of 15 plants, with only the three central plants constituting the useful plot. The sprinkler irrigation system was used, applying, in the absence of rain, 3 mm of water per day, and spontaneous plants were controlled through manual weeding. No pest and disease control was necessary.

The harvest was made on 07/28/2015, and the diameter, height, number of leaves, fresh and dry weight of the cabbage were evaluated. The dry weight was obtained after drying in forced circulation air oven at 65 °C until reaching constant weight.

Data were submitted to analysis of variance and regression analysis was performed for castor bean doses. The data were processed by the statistical program Sisvar 5.3 (Ferreira, 2011). To compare the doses of castor bean cake with the control (inorganic fertilizer in top dressing), the Dunnett test was used at 5 % probability, using the Assistat 7.7 statistical program (Silva & Azevedo, 2016).

Results and Discussion

The higher the doses of castor bean cake in top dressing, the higher the fresh weight of the cabbage. The lowest fresh weight was estimated in 519 g for the treatment without fertilization in top dressing (dose 0) and the highest was 1470 g for the highest dose (250 g m^{-2}) (Figure 1A). For each 1 g m^{-2} of castor bean cake applied in top dressing, an increase of 3.8 g in the weight of the cabbage is estimated.

The values obtained are within the range, or slightly lower, of values obtained by Aquino et al. (2005), Silva et al. (2011) and Corrêa et al. (2013), and higher than those of Moreira et al. (2011). It is emphasized that the weight of the cabbage depends on the genotype, the spacing, the climatic conditions, among other factors. However, the values obtained in the highest doses of castor bean cake are within the range considered as ideal for commercialization, according to Aquino et al. (2005), which is 1.0 to 1.5 kg per cabbage, because larger plants generally have less commercial acceptance.

The same effect, linear increase the higher the dose of castor bean cake, was observed for dry matter weight (Figure 1B), diameter (Figure 1C), height (Figure 1D), and number of leaves (Figure 1E), with maximum values obtained in the highest dose (250 g m^{-2}) of 103 g, 16.4 cm, 10.9 cm and 30 leaves per plant, respectively. For each 1 g m^{-2} of castor bean cake applied in top dressing, an increase of 0.27 g in dry weight, 0.15 mm in diameter, 0.11 mm in height and 0.032 leaves per plant is estimated.

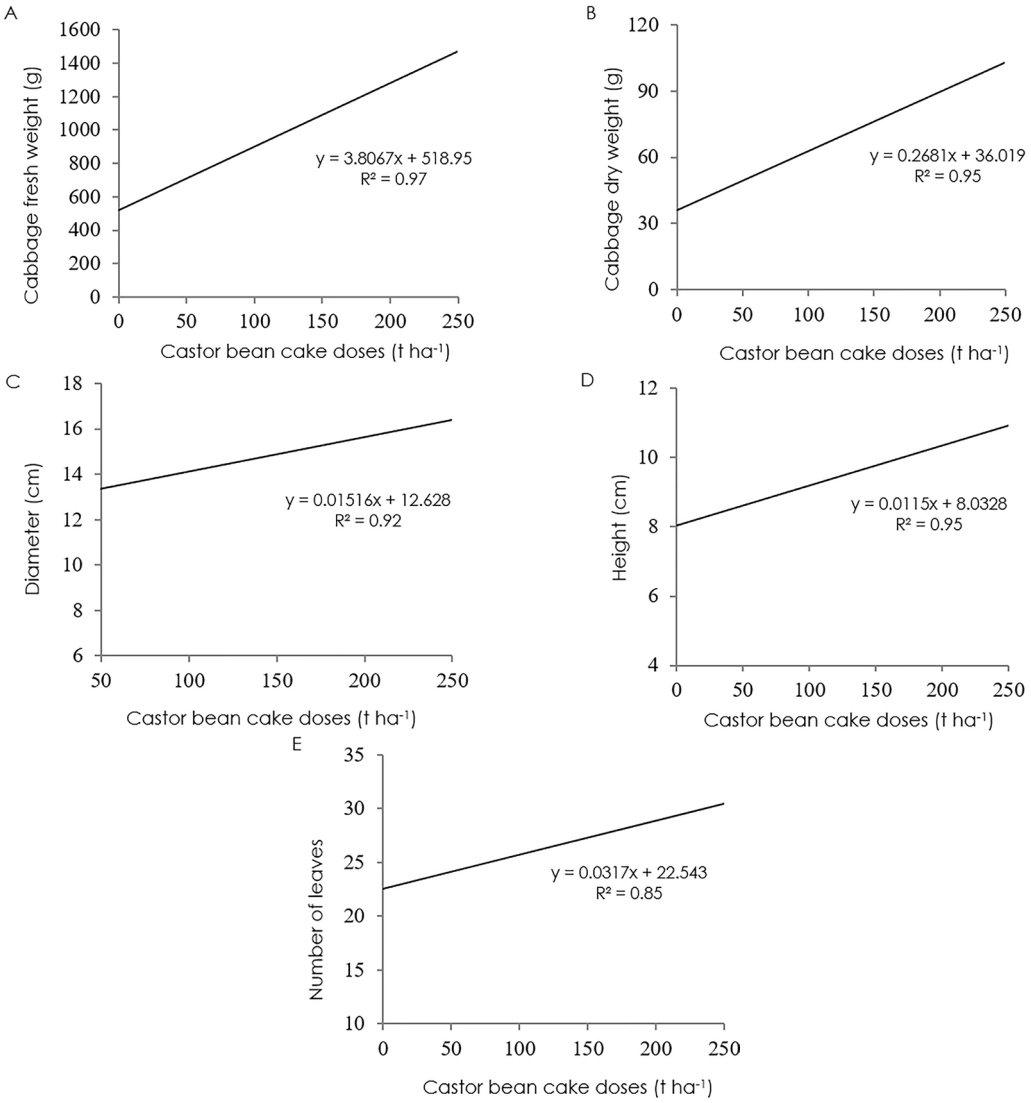

Figure 1. Fresh (A) and dry (B) weight, diameter (C), height (D) and number of leaves (E) of the cabbage as a function of the doses of castor bean cake in top dressing. São Manuel-SP, 2015.

Again, the values obtained at higher doses are similar to those obtained by other authors (Aquino et al., 2005; Moreira & Vidigal, 2011; Moreira et al., 2011; Corrêa et al., 2013). The fact that these characteristics related to the cabbage presented the same behavior in relation to the doses of castor bean cake are justified, because, generally, the higher the height and the diameter, the bigger the cabbage and, therefore, the greater its weight. Cordeiro et al. (2018) obtained higher values of fresh weight of the whole plant, cabbage "head" average weight and N content, with an application of organic compost in topdressing in relation to its absence. Cardoso et al. (2020) related that top dressing fertilization with castor bean cake resulted in greater yield in cabbage, producing heads with higher weight, diameter and length than the organic compost.

Probably, the effect of the castor bean cake was to release the nutrients to the plants. According to Costa et al. (2004), the castor bean cake presents good characteristics for use as an organic fertilizer, as it is an excellent source of nitrogen, potassium and phosphorus. No studies were found in which castor bean cake was studied in cabbage in top dressing. However, Silva et al. (2016) also reported linear increases in diameter, length and weight of fresh beet matter with the use of up to 600 g m^{-2}. On the other hand, Santos et al. (2012) did not find significant differences in onion production, with castor bean cake in top dressing, and explained this result because of the high initial fertility of the soil and also because of the base fertilization made with bovine manure. The soil where this research was conducted was not initially poor in nutrients, and fertilization was done before planting with organic fertilizer, and even then, there was response of the cabbage to the doses of castor bean cake in top dressing. The highest dose (250 g m^{-2}) corresponds to 119.75 kg ha^{-1} of N, similar to the average dose recommended by Raij et al. (1997) for cabbage in the State of São Paulo, which is 15 to 200 kg ha^{-1}.

In the comparison of the castor bean cake doses with the control with inorganic fertilization, it was observed that for all evaluated characteristics the highest dose of castor bean cake (250 g m^{-2}) did not differ from the inorganic fertilization control. Also the second highest dose (200 g m^{-2}) did not differ from the inorganic fertilization control for most of the characteristics, including the most commercially important, which is the weight of the fresh matter of the cabbage. The treatment without fertilization (dose 0) and the lowest dose (50 g m^{-2}) were inferior to the inorganic fertilization control for all the characteristics (Table 1).

Table 1. Comparison of treatments with castor bean cake in relation to inorganic fertilization for fresh (FW) and dry (DW) weight, height, diameter and number of leaves of cabbage plants. São Manuel-SP, 2015.

Castor bean cake doses (g m^{-2})	FW (g)	DW (g)	Height (cm)	Diameter (cm)	Number of leaves
0	508*	34.4*	8.04*	12.01*	22.8*
50	722*	49.6*	8.79*	13.58*	23.8*
100	951*	68.0*	9.53*	14.79	25.2
150	976*	68.0*	9.36*	14.81	29.0
200	1359	98.0	10.54*	15.81	27.0
250	1453	99.2	10.88	16.05	31.2
inorganic control	1444	94.4	11.94	153.20	28.4
CV (%)	20.5	8.1	20.0	6.4	9.2

*Mean statistically lower than the control with inorganic fertilization by the Dunnett test at 5 % probability.

Considering only the N and K, which are the recommended nutrients in top dressing for cabbage (Raij et al., 1997), in the inorganic control were applied 11.5 g of N and 5.4 g of K_2O per m^2. Each 100 g m^{-2} of the castor bean cake used has the potential to release up to 4.3 g of N and 0.9 g of K_2O per m^2. Therefore, at the highest dose, about 11 g of N and 2.3 g of K_2O were applied, the "dose" of N resembling to the inorganic control. K was applied in lesser doses than the recommended, because castor bean cake is not rich in this nutrient. However, Corrêa et al. (2013) reported that this same cabbage hybrid did not have its production altered with different doses and sources of potassium. In contrast, there are several studies in which the crop responded to the inorganic nitrogen fertilization in top dressing (Aquino et al., 2009; Moreira & Vidigal, 2011; Moreira et al., 2011), confirming the importance of this nutrient in top dressing fertilization in cabbage production.

As castor bean cake is an easily decomposed material (Severino et al., 2004), probably the rapid release and availability of nutrients to the plants may explain the positive results observed, being possible to obtain cabbage production only with organic fertilization similar to inorganic fertilization. Gomes et al. (1963), in the production of potato, observed that the castor bean cake applied in the planting significantly supplied the ammonium sulfate, resulting in better production and commercial classification of the tuber. Silva et al. (2016) also obtained beet production with application of castor bean cake in top dressing similar to inorganic fertilization.

Perhaps larger doses of castor bean cake could increase cabbage production, because the result was a linear increase. In addition, the application of the cake was superficial and only partially incorporated during the weeding. Thus, the contact with microorganisms responsible for mineralization is smaller in relation to the application followed by incorporation to the soil, which would increase the microbial activity, essential for mineralization and availability of nutrients by organic matter (Monsalve et al., 2017). However, not always larger cabbages are commercially better. Usually, the ideal is cabbage of 1.0 to 1.5 kg (Aquino et al., 2005), so it is not commercially interesting to test larger doses of castor bean cake for cabbage production.

The superficial application can help to maintain the temperature and the humidity of the soil, as organic materials applied on the surface of the ground work as a cover of the same. Zárate et al. (2010) used partially decomposed chicken manure as a soil cover (10 t ha^{-1}) placed immediately after planting the bunching onion and observed increasing in yield. They reported that the reasons for these higher yields were the soil protection, with lower heating and drying of the surface layer. Probably, the castor bean cake applied in the present study also served for soil protection.

The results obtained with a linear increase in cabbage production and the fact that the highest doses did not differ from the inorganic control show that the castor bean cake was able to provide nutrients in sufficient quantities for the good development of the plant, proving the technical viability of its use.

Conclusions

The higher the dose of castor bean cake in top

dressing, the greater the production of cabbage.

It may be recommended to apply at least 200 g m^{-2} of castor bean cake in top dressing to cabbage production.

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