horticultura brasileira

Scientific communication

CARDOSO, AII; OLIVEIRA, JB; LANNA, NBL; CANDIAN, JS; CASTRO, JLM. 2020. Sources and splitting of the organic fertilization in top dressing in cabbage production. *Horticultura Brasileira* 38: 230-234. DOI - http://dx.doi.org/10.1590/S0102-053620200217

Sources and splitting of the organic fertilization in top dressing in cabbage production

Antonio Ismael Inácio Cardoso [1]; Jéssica B Oliveira [1]; Natália BL Lanna [1]; Joara S Candian [2]; Jean Lucas M Castro [1]

[1]Universidade Estadual Paulista (UNESP), Botucatu-SP, Brasil; antonio-ismael.cardoso@unesp.br; jessica-jc15@hotmail.com; nataliabllanna@gmail.com; jeanlucas1994.jl@gmail.com; [2]Horticulture building, UGA, Tifton, GA, USA; joara@live.com

ABSTRACT

Although there exist researches about fertilization in top dressing in the production of cabbage, these are usually made with inorganic fertilizers, being rare the researches with organic fertilization in top dressing in the production of most vegetables. The objective was to evaluate the effect of different splitting of two organic fertilizers in top dressing in the production of cabbage. Six treatments were evaluated, with four replications in randomized block design. The six treatments were the result of the factorial 3x2, with three types of splitting (1/3+1/3+1/3; 4/6+1/6+1/6; 1/6+4/6+1/6 of the total dose in each application) and two organic fertilizers (castor bean cake and organic compost). The total dose of each fertilizer was calculated to apply 120 kg ha^{-1} N. The evaluated characteristics were number of external leaves, fresh weight of external leaves (g), fresh and dry head weight (g), head diameter (cm) and length (cm), yield and crop cycle (days after transplanting). Fertilization with castor bean cake resulted in greater yield, producing heads with higher weight, diameter and length in relation to the organic compost, besides reducing the cycle. The 4/6+1/6+1/6 splitting was better than the 1/6+4/6+1/6 splitting using castor bean cake.

Keywords: *Brassica oleracea* var *capitata*, nitrogen, castor bean cake, organic compost.

RESUMO

Fontes e parcelamentos da adubação orgânica em cobertura na produção de repolho

Apesar de existirem pesquisas com adubação em cobertura na produção de repolho, estas geralmente são feitas com adubos inorgânicos, sendo raras as pesquisas com adubação orgânica em cobertura na produção da maioria das hortaliças. Objetivou-se avaliar o efeito de diferentes parcelamentos de dois adubos orgânicos em cobertura na produção de repolho. Foram avaliados seis tratamentos, com quatro repetições no delineamento em blocos ao acaso. Os seis tratamentos foram resultantes do fatorial 3 x 2, sendo três tipos de parcelamentos (1/3+1/3+1/3; 4/6+1/6+1/6; 1/6+4/6+1/6 da dose total em cada aplicação) e dois adubos orgânicos (torta de mamona e composto orgânico). A dose total de cada adubo foi calculada para se aplicar 120 kg ha^{-1} de N. As características avaliadas foram número e massa fresca (g) das folhas externas, massa fresca e seca da cabeça (g), diâmetro (cm) e altura (cm) da cabeça, produtividade e ciclo (dias após o transplante). A torta de mamona favoreceu aumento da produtividade, com a produção de cabeças com maior massa fresca, diâmetro e altura em relação ao composto orgânico, além de reduzir o ciclo. Para a torta de mamona o parcelamento 4/6+1/6+1/6 foi melhor que o parcelamento 1/6+4/6+1/6.

Palavras-chave: *Brassica oleracea* var *capitata*, nitrogênio, torta de mamona, composto orgânico.

Received on September 13, 2019; accepted on April 15, 2020

In order to achieve high crop productivity and crop sustainability, farmers' interest in organic fertilization has been increasing (Magro *et al*., 2015). The use of organic fertilization promotes the improvement of soil fertility and contributes to increase yield and crop quality, as well as to improve soil physical, chemical and biological conditions thanks to its use (Magro *et al*., 2010; Trani *et al*., 2013).

The brassicas are among the crops that most respond to organic fertilization, which may replace the mineral fertilizers with satisfactory results (Kimoto, 1993). In general, brassicas are poorly tolerant to soil acidity and high demanding for some nutrients, such as calcium, sulfur and boron (Filgueira, 2008) and present a positive response to organic fertilization (Magro *et al*., 2010; Candian *et al*., 2015; Corrêa *et al*., 2016). Most researches are related to the use of organic fertilizers before planting, however, for most species of vegetables, including the brassicas, there are few recommendations and publications regarding the organic fertilization in top dressing. Among the options of organic fertilization adopted by vegetable producers, we have the castor bean cake (Silva *et al*., 2016).

According to Costa *et al*. (2004), the castor bean cake presents excellent characteristics as organic fertilizer, because it is a source of phosphorus, potassium, calcium, sulfur, all micronutrients and, mainly, nitrogen. Although this product is used, there is

little scientific information on its use as an organic fertilizer. Besides castor bean cake, there are other organic fertilizers that should be studied in order to obtain alternatives for the organic producers. Among these options, we have the organic composts, already widely used by farmers in planting fertilization. However, these usually have lower N content than castor bean cake. Cordeiro *et al*. (2018) reported higher yield in cabbage using organic compost in top dressing only when they do not use green manure before planting.

However, in addition to the comparison of sources, there are also no studies indicating the best time and parceling of these organic fertilizers in top dressing, considering that the need for nutrients by the cabbage plant should be higher at the beginning of the formation and development of the "head". Nitrogen fertilizers should be splitted, with the greatest amount being applied in top dressing (Silva *et al*., 2016; Candian, 2018; Colombari *et al*., 2018).

Cabbage (*Brassica oleracea* var. *capitata*) is the brassica with the largest area planted in Brazil and, even with this importance, few researches were found with organic fertilization in top dressing (Cordeiro *et al*., 2018), but several with inorganic fertilization (Moreira & Vidigal, 2011; Moreira *et al*., 2011; Corrêa *et al*., 2013). In view of the above, the objective of this study was to evaluate the effect of different splitting of two organic fertilizers in top dressing in cabbage production.

MATERIAL AND METHODS

The experiment was carried out under field conditions, at São Manuel Experimental Farm, located in the municipality of São Manuel-SP (22°46'28''S, 48°34'37''W, 750 m altitude), at São Paulo State University (UNESP), *campus* Botucatu-SP. The local climate is Cfa (Temperate Mesothermal), according to Köppen's international classification (Cunha & Martins, 2009).

The soil of the experimental area was classified as typic distrophic Red Latosol, sandy texture. Chemical analysis (0-20 cm) showed: pH ($CaCl_2$)= 4.7; organic matter = 13 g dm^{-3}; P= 86 mg dm^{-3}; H+Al= 25 $mmol_c$ dm^{-3}; K= 3.4 $mmol_c$ dm^{-3}; Ca= 28 $mmol_c$ dm^{-3}; Mg= 6 $mmol_c$ dm^{-3}; sum of bases (SB)= 37 $mmol_c$ dm^{-3}, CEC= 62 $mmol_c$ dm^{-3} and base saturation (V%)= 60%. In planting fertilization, only organic compost Provaso® (50 t ha^{-1}) was applied, as recommended by Raij *et al*. (1997) for cabbage, and its chemical analysis showed values of organic matter; N; P_2O_5; K_2O; Ca; Mg and S, expressed in % of dry matter, respectively: 41; 2.15; 0.79; 1.30; 3.70; 0.50 and 0.25. The moisture of the compost was 27.9%.

Six treatments were evaluated, with four replications in the randomized block design. The treatments were the result of the factorial 3 x 2, with three types of splitting (1/3+1/3+1/3; 4/6+1/6+1/6; 1/6+4/6+1/6 of the total dose in each application) and two organic fertilizers (castor bean cake and organic compost). For all treatments, the total dose of each organic fertilizer was calculated to apply 120 kg ha^{-1} N, as recommended by Raij *et al*. (1997). The castor bean cake and the organic compost had 5.0% and 2.15% N, respectively. Top dressing applications have been made at 14, 28 and 44 days after seedlings transplantation (DAT). In each application the amount of the fertilizer was calculated (castor bean cake and the organic compost) for one plant and applied around the plant above the ground, without incorporate to avoid damaging the roots. The organic compost used for top dressing fertilization was the same described for fertilization before planting. The castor bean cake chemical analysis showed values of organic matter; N; P_2O_5; K_2O; Ca; Mg and S, expressed in % of dry matter, respectively: 82; 5.00; 0.91; 0.96; 1.83; 0.76 and 0.29. The castor bean cake moisture was 9.1%.

The plots were composed of three lines containing six plants each, and the useful plot being formed by the four central plants. The spacing was 60 x 35 cm. The hybrid Kenzan used in this research was sown on May 30, 2016 and the seedlings were transplanted on June 27, 2016. Sprinkler irrigation was used, about 3 mm per day, and spontaneous plants were controlled through manual weeding.

The cabbage heads were harvested when they were very firm; the following characteristics were evaluated: cycle (DAT), number of external leaves (still green), length and diameter of the head (cm), external leaves and head fresh weight (g), head dry weight (g) (obtained after drying in a forced air circulation oven at 65°C for seven days until reaching constant weight). Yield was estimated considering just the fresh weight of head and a population of 47,619 plants/ha. Data were submitted to analysis of variance and Tukey test ($p<0.05$) was used to compare averages, using the statistical software Sisvar (Ferreira, 2011).

RESULTS AND DISCUSSION

According to analysis of variance, an interaction was observed between the types of splitting and sources of organic fertilizer for the characteristics fresh weight of head and external leaves, yield, head diameter and head length (Table 1), while for dry weight of head and cycle only the organic fertilizer sources factor was significant (Table 2).

For the number of external leaves, there was no difference, independently of the fertilizer source and the splitting, with an average of 25.1 leaves per plant (Table 1). According to Kimoto (1993), the external leaves are the first to be formed and their number depends on the genotype, the environmental conditions, the soil fertility and the fertilization done before planting. The top dressing fertilization affects more intensively the leaves that will form the head of the cabbage, because it is applied after the formation of the external leaves. Therefore, considering that the fertilization made before planting was the same for all treatments, the result was expected. Corrêa *et al*. (2013) also did not observe difference in the number of external leaves of the same hybrid Kenzan, in two seasons, regardless of the dose and the potassium fertilizer source in top dressing, with a mean of 23 leaves.

Using castor bean cake, a higher fresh matter weight of external leaves was obtained compared to the organic compost in two splittings: 4/6+1/6+1/6 and 1/6+4/6+1/6 (Table 1). For fresh weight, diameter and length of head, and yield, castor bean cake was superior to organic compost in splitting 4/6+1/6+1/6 (Table 1), an increase of 78%, 22%, 25% and 78%, respectively. For head dry weight, the castor bean cake was superior (45%) to the organic compost, regardless of the type of splitting (Table 2), showing that although the amount of N applied was the same (120 kg ha^{-1}), the castor bean cake should exhibit faster release of nutrients than organic compost. According to Severino *et al*. (2004), castor bean cake is a material with high microbial activity, and its decomposition is very fast, and nutrients are more readily available to the plants soon after their addition to the soil, and may be the reason for the superior results in relation to the organic compost. In addition to nitrogen, other nutrients in castor bean cake should also have been released faster compared to organic compost, which favored greater dry weight accumulation, because castor bean cake has all macronutrients, as highlighted in the chemical analysis performed and presented in the methodology.

Table 1. Averages of fresh weight of head and external leaves, yield, diameter and length of cabbage head depending on splitting and organic fertilizers in top dressing. Botucatu, UNESP, 2017.

Sources	Splitting		
	1/3+1/3+1/3	4/6+1/6+1/6	1/6+4/6+1/6
	Number of external leaves		
Organic compost	24.6 Aa	26.3 Aa	25.9 Aa
Castor bean cake	25.2 Aa	24.3 Aa	24.3 Aa
CV (%)		9.0	
	Fresh weight of head (g)		
Organic compost	450 Aa	329 Ab	366 Aa
Castor bean cake	417 Aa	585 Aa	455 Aa
CV (%)		23.1	
	Yield (t ha^{-1})		
Organic compost	24.4 Aa	15.7 Ab	17.4 Aa
Castor bean cake	19.9 Aa	27.9 Aa	21.7 Aa
CV (%)		23.1	
	Fresh weight of external leaves (g)		
Organic compost	531 Aa	443 ABb	429 Bb
Castor bean cake	593 Ba	736 Aa	574 Ba
CV (%)		9.1	
	Diameter of head (cm)		
Organic compost	10.7 Aa	9.7 Ab	10.8 Aa
Castor bean cake	9.9 Aa	11.8 Aa	10.7 Aa
CV (%)		9.0	
	Head length (cm)		
Organic compost	8.5 Aa	7.3 Ab	8.5 Aa
Castor bean cake	7.9 Aa	9.1 Aa	8.3 Aa
CV (%)		8.6	

Averages followed by same letters, uppercase in lines and lowercase in columns, do not differ from each other, Tukey test at 5% probability. CV= coefficient of variation.

Some studies have already demonstrated the beneficial effect of castor bean cake, such as in potato (Gomes *et al*., 1963), lettuce (Souza, 2008) and banana (Lins *et al*., 2013), but applications were made before planting. Applied in top dressing, it resulted in a linear increase in beet production, the higher the dose (Silva *et al*., 2016), however, it did not present significant effects on the production of onion bulbs in a soil of high initial fertility (Santos *et al*., 2012). Candian (2018) reported linear increases in cauliflower production, the higher the dose of castor bean cake in top dressing when the author carried out the research in an area with low fertility soil. On the other hand, when the research was carried out on a certified property, with soil rich in organic matter, the results of increased productivity were adjusted to the quadratic model, with small increase in the best dose in comparison to the absence of fertilization in top dressing with castor bean cake.

In addition to the superior results for the characteristics of the head (fresh and dry weight, diameter and length) and yield, the castor bean cake was also advantageous in relation to the organic compost because it provided a shorter cycle, regardless of the type of splitting (Table 2). The harvest was done, in average, three days before with castor bean cake. It does not look like much, but it is three days less to take care of the plants, with reduced costs, especially with irrigation. Candian (2018) also observed a reduction of two days in the cauliflower cycle with the application of castor bean cake, explaining that the nitrogen provided by this organic fertilizer favors the foliar development, allowing the plant to have more photoassimilates, transforming them into energy for its development. Also Souza *et al*. (2010) observed a reduction in the sunflower cycle with the use of nitrogen-rich wastewater. Besides nitrogen, castor bean cake has all other nutrients that are released faster than the organic compost, and favors the development of plants, faster cycle and greater production.

Using organic compost, splitting did not affect the characteristics of the

Table 2. Averages of cycle and dry weight of head of cabbage plants depending on organic fertilizers in top dressing. Botucatu, UNESP, 2017.

Sources	Cycle (days after transplanting)	Dry weight of head (g)
Organic compost	101 a[1]	29.4 b
Castor bean cake	98 b	42.7 a
CV (%)	3.2	25.7

[1]Averages followed by same letters, in columns, do not differ from each other, Tukey test at 5% probability. CV= coefficient of variation.

cabbage head (fresh weight, diameter and length) and yield. On the other hand, for the fresh weight of the external leaves, the splitting 1/3+1/3+1/3 resulted in higher values compared to 1/6+4/6+1/6 (Table 1). However, when the castor bean cake was used, the 4/6+1/6+1/6 splitting resulted in heads with higher fresh weight and yield than the 1/6+4/6+1/6 splitting. Candian (2018) also reported higher fresh weight of cauliflower inflorescence when applied 2/3 of the castor bean cake dose in relation to 1/3 application in the first application. So it seems that it is better to apply a higher proportion of the castor bean cake in the first top dressing.

Despite the higher nutrient demand in *B. oleracea* being at the beginning of head formation (Castoldi *et al*., 2009), that is, in the last third of the cycle, the organic fertilizers have a slower release of nutrients than the inorganic ones, being necessary to put in the cycle sooner, so that the nutrients are already available in the stage of greater nutritional demand. In this way, the higher the proportion in the first application, the better the result, as observed in this research. If an organic fertilizer is put in the higher demand stage it will not release the nutrients, mainly N, at the proper time.

The application of the organic fertilizers was superficial and only partially incorporated during weeding. Thus, contact with microorganisms responsible for mineralization is lower in relation to the application followed by incorporation to the soil, which would increase the microbial activity, essential for the mineralization and availability of nutrients by organic matter (Monsalve *et al*., 2017), as it was made with fertilization before planting. But, when the plants are already well established, the incorporation of organic fertilization can be harmful for the roots and incorporation should be avoided. In addition, organic fertilizers present slower release compared to the inorganic ones, and need higher doses to have the same effect in short time, especially when they are not incorporated. Silva *et al*. (2016) obtained a linear effect for beet yield characteristics with increases in castor bean doses up to the dose corresponding to 200% of the recommended for inorganic N. Therefore, perhaps larger doses of organic fertilizers could increase cabbage production. However, Candian (2018) observed a drop in cauliflower production with high doses of castor bean cake when the soil is already rich in organic matter. Fonseca & Soto-Blanco (2014) reported that the toxic effects of certain substances presented in this cake are considerable. Therefore, very high doses, besides the cost, can be harmful to vegetable production.

For top dressing fertilizer application, in an organic cabbage production system, it is recommended to use castor bean cake in relation to organic compost and the 4/6+1/6+1/6 split form is the best application option for the evaluated organic fertilizers.

ACKNOWLEDGEMENTS

The authors acknowledge the CNPq and CAPES for the scholarships granted.

REFERENCES

CANDIAN, JC. 2018. *Doses and times of application of castor bean cake in the production, physicochemical characteristics and macronutrient contents in cauliflower under organic management*. Botucatu-SP: UNESP-FCA. 66p. (Ph.D. Thesis)

CANDIAN, JC; MARTINS, BNM; CARDOSO, AII. 2015. Doses of organic compost in the early development of cauliflower and chemical characteristics of the soil. *Cultivando o Saber* 8: 257-266.

CASTOLDI, R; CHARLO, HCO; VARGAS, PF; BRAZ, LT. 2009. Growth, nutrients accumulation and crop productivity of cauliflower. *Horticultura Brasileira* 27: 438-446.

COLOMBARI, LF; LANNA, NBL; GUIMARÃES, LRP; CARDOSO, AII. 2018. Production and quality of carrot in function of split application of nitrogen doses in top dressing. *Horticultura Brasileira* 36: 306-312.

CORDEIRO, AAS; RODRIGUES, MB; GONÇALVES JR, M; ESPÍNDOLA, JAA; ARAÚJO, ES; GUERRA, JGM. 2018. Organic cabbage growth using green manure in pre-cultivation and organic top dressing fertilization. *Horticultura Brasileira* 36: 515-520.

CORRÊA CV; CARDOSO AII; CLAUDIO MTR. 2013. Yield of cabbage depending on rates and sources of potassium in top dressing. *Semina: Ciências Agrárias* 34: 2129-2138.

CORRÊA, CV; GOUVEIA, AMS; MARTINS, BNM; TAVARES, AEB; LANNA, NBL; CARDOSO, AII; EVANGELISTA, RM. 2016. Response of broccoli to sulphur application at top dressing in the presence or absence of organic compost at planting. *African Journal of Agricultural Research* 11: 3287-3292.

COSTA, FX; SEVERINO, LS; BELTRÃO, NEM; FREIRE, RMM; LUCENA, AMA; GUIMARÃES, MMB. 2004. Avaliação de teores químicos na torta de mamona. *Revista de Biologia e Ciências da Terra* 4: 7p.

CUNHA, AR; MARTINS, D. 2009. Classificação climática para os municípios de Botucatu e São Manuel, SP. *Irriga* 14: 1-11.

FERREIRA, DF. 2011. Sisvar: a computer statistic analysis system. *Ciência e Agrotecnologia* 35: 1039-1042.

FILGUEIRA, FAR. 2008. *Novo manual de olericultura:* agrotecnologia moderna na produção e comercialização de hortaliças. Viçosa: UFV. 421p.

FONSECA, NBS; SOTO-BLANCO, B. 2014. Toxicity of ricin present in castor bean seeds. *Semina: Ciências Agrárias* 35: 1415-1424.

GOMES, AG; GARGANTINI, H; VENTURINI, WR. 1963. Competição entre fertilizante orgânico e mineral na cultura da batatinha. *Bragantia* 22: 575-581.

KIMOTO, T. 1993. Nutrição e adubação de repolho, couve-flor e brócolo. In: FERREIRA, ME; CASTELLANE, PD; CRUZ, MCP (eds). *Nutrição e adubação de hortaliças*. Piracicaba: Potafos. p.149-178.

LINS, LCR; FANCELLI, M; RITZINGER, CHSP; COELHO FILHO, MA; LEDO,

CAS. 2013. Castor bean pie on the control of banana weevil borer (*Cosmopolites sordidus*) in banana 'Terra'. *Revista Brasileira de Fruticultura* 35: 493-499.

MAGRO, FO; ARRUDA, N; CASA, J; SALATA, AC; CARDOSO, AII; FERNANDES, DM. 2010. Organic compost in broccoli seed yield and quality. *Ciência e Agrotecnologia* 34: 596-602.

MAGRO, FO; SILVA, EG; TAKATA, WHS; CARDOSO, AII; FERNANDES, DM.; EVANGELISTA, RM. 2015. Organic compost and potassium top dressing fertilization on production and quality of beetroot. *Australian Journal of Crop Science* 9: 962-967.

MONSALVE, OI; GUTIÉRREZ, JS; CARDONA, WA. 2017. Factores que intervienen em el processo de mineralización de nitrógeno cuando son aplicadas en meiendas orgânicas al suelo. *Revista Colombiana de Ciências Horticolas* 11: 200-209.

MOREIRA, MA; VIDIGAL, SM. 2011. Plant parameters associated with adequate nutritional nitrogen status of cabbage. *Ceres* 58: 243-248.

MOREIRA, MA; VIDIGAL, SM; SEDIYAMA, MAN; SANTOS, MR. 2011. Growth and yield of cabbage depending on nitrogen rates. *Horticultura Brasileira* 29: 117-121.

RAIJ, BV; CANTARELLA, H; QUAGGIO, JA; FURLANI, AMC. 1997. *Recomendações de adubação e calagem para o Estado de São Paulo*. 2. ed. Campinas: Instituto Agronômico & Fundação IAC, p.175.

SANTOS, SS; ESPÍNDOLA, AAA; GUERRA, JGM; LEAL, MAA; RIBEIRO, RLD. 2012. Production of organically grown onions depending on the use of mulch and castor bean cake. *Horticultura Brasileira* 30: 549-552.

SEVERINO, LS; COSTA, FB; BELTRÃO, NEM; LUCENA, AMA; GUIMARÃES, MMB. 2004. Mineralização da torta de mamona, esterco bovino e bagaço de cana estimada pela respiração microbiana. *Revista de Biologia e Ciências da Terra* 5: 1-6.

SILVA, PNL; LANNA, NBL; CARDOSO, AII. 2016. Beet production depending on rates of castor bean cake as top dressing. *Horticultura Brasileira* 34: 416-421.

SOUZA, IP. 2008. *Adubação orgânica de alface com co-produto do biodiesel*. Lavras: UFLA. 42p. (M.Sc. Dissertation)

SOUZA, RM; NOBRE, RG, GHEYI, HR, DIAS, NS; SOARES, FAL. 2010. Utilization of wastewater and organic manure in cultivation of sunflower. *Revista Caatinga* 23: 1-10.

TRANI, PE; TERRA, MM; TECCHIO, MA; TEIXEIRA, LAJ; HANASHIRO, J. 2013. *Adubação orgânica de hortaliças e frutíferas***.** Campinas, SP: Instituto Agronômico.