 Doi: 10.33158/ASB.r113.v6.2020

Doses of bokashi in the growth of two basil cultivars

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ABSTRACT

The present work aimed to evaluate the influence of use, as well as to determine adequate doses in organic fertilization of the bokashi type in the cultivation of two basil (*Ocimum basilicum* L.) cultivars. Seeds from the collection of the Floriculture Laboratory of the Phytotechnics Department of the Federal University of Ceará were used. The treatments used were arranged in a randomized block design (RBD), arranged in a 2x5 factorial scheme, consisting of two cultivars of basil (Genovese and Anão) and five doses of Bokashi, namely: 0, 3, 6, 9 and 18 g.L^{-1}. Plants that received no dose (0 g.L^{-1}) served as a control treatment. Each treatment contained 5 repetitions, with the plot consisting of 7 pots, one plant per pot, the useful unit a pot with a basil seedling. From the transplant, applications of bokashi were started in doses of 0, 3, 6, 9, and 18 g.L^{-1} in both cultivars. Both applications were performed every 20 days after the first application of Bokashi. Fivety five days after transplantation in the final pot, the following variables were analyzed: plant height, stem diameter, fresh and dry mass of the aerial part and the root. The 9 g.L^{-1} dose of Bokashi showed the best results for the variables analyzed for both cultivars, in addition to being efficient when compared to the control, in which the vegetative growth was incipient.

Keywords: Lamiaceae, pot cultivation, organic fertilizer, spice plants, substrate, condiment.

INTRODUCTION

Basil (*Ocimum basilieum* L.), a species of the Lamiaceae family, is a plant originated from India, which has several purposes, mainly for obtaining essential oil, and it is also widely explored in cooking as a condiment. In Brazil, Ocimum species are considered restorative herbs for human health, which relieves spasms, lowers fever and improves digestion, in addition to being effective against intestinal infections (Favorito et al, 2011). The Brazilian production of basil is practiced mainly by small producers and is aimed at the commercialization of aromatic green leaves (May, Tanaka, Silva, & Pinheiro, 2005).

As an alternative for synthetic fertilization, the use of agricultural-industrial residues to obtain organic fertilizers through fermentative processes can be an advantageous way of adding value to a disposal product, as well as generating an alternative source of income for rural properties, or allowing them to be more self-sufficient in relation to the demand for fertilizers on the property, thus fulfilling an environmental and social function (Oliveira, et al. 2014).

Organic fertilization is of great importance in the cultivation of vegetables, ornamental, aromatic and medicinal plants, specially in soils of tropical climate, where the decomposition of organic matter occurs intensely, and its effect is known in the physical, chemical and biological properties of the soil (Swift & Woomer, 1993; Preti et al., 2015; Hoshino, Colombo, Zandoná, Alves, & Faria, 2017). Organic fertilization also includes the use of various organic residues in order to increase crop productivity (Ribeiro, Lopes, Martins-Filho, & Ramalho, 2000).

"Bokashi" consists of an organic fertilizer, rich in organic matter, nitrogen, phosphorus and potassium, which can replace traditional chemical fertilizers and can be applied both in planting and cover fertilization in the cultivation of several species (Hafle, Santos, Ramos, Cruz, & Melo 2009). In view of the importance of Bokashi in vegetable production, the present study aimed to determine the use and the most appropriate dosage for the cultivation of basil, grown in pots, testing different doses of fertilizer in the development of two cultivars: Genovese and Anão.

MATERIALS AND METHODS

The experiment was carried out from September to December 2015, at the Orquidário-UFC of the Department of Phytotechnics, at the Center for Agricultural Sciences of the Federal University of Ceará - Campus do Pici, Fortaleza-CE, located at 03º44'17.3 ” South Latitude, 38º34'29.1 ”West Longitude and average altitude of 21 m. According to Köppen classification from 1948, the climate is Aw 'type, rainy tropical, with temperature in the period of realization of the present work of 27 °C. The greenhouse used has a ceiling height of 4.5 m, and a 150 micron diffuser plastic film cover. The brightness of the room with 200 to 700 µmol.m-2s-1, obtained through readings performed with the aid of a portable digital luximeter, model LD-200 at 12:00 am.

The seeds used were of the species *Ocimum basilieum* L. (Lamiaceae), cultivars Genovese and Anão (Figure 1), from the collection of the Floriculture Laboratory, at the Federal University of Ceara, with a purity of 99% and germination 80% for both planted cultivars.

Figure 1. Anão (A) and Genovese (B) basil cultivars.
Source: Silva, C.F (2016).

Sowing was carried out on September 24th, 2015, with the sowing of two cultivars of basil in plastic trays of two hundred cells (volume 18 cm^3). After the seedlings reached a height of approximately 5 cm and two pairs of real leaves, transplantation was carried out into plastic pots (Figure 2) filled with coconut fiber substrate. The cultivation was carried out in pots (15), 11.5 cm high and 14.5 cm in diameter, filled with coconut fiber of the coconut fiber type, with pH=5.2 and EC=1.2dS.m^{-1}.

Bokashi was produced by the Center for Studies and Research in Floriculture and Ornamental Plants - CEFLOR, at the Federal University of Ceará, Fortaleza. To obtain Bokashi, materials and components used were: corn bran and cotton in the ratio 1 / 0.5 respectively, crushed coal, sugar molasses, Thermophosphate and Yakult.

All the ingredients were mixed in water until they formed a homogeneous paste, adding water for the dilution and preparation of the paste of the material until reaching the most homogeneous paste possible. Soon after, the pasty mixture was stored in appropriate containers, clean and with a lid, where it remained sealed for two months, in order to prevent the entry of air and contaminants. The containers were opened after two months, a period necessary for anaerobic fermentation, where the ready fertilizer was used in the present experiment. The Bokashi used in the present work presented the results showed in the Table 1 (FUNCEME analysis laboratory).

Table 1. Chemical composition Bokashi produced at Orquidário UFC.

Results												
g.L^{-1}									mg.L^{-1}			
N	P	P2O5	K	K2O	Ca	Mg	S	Na	Fe	Cu	Zn	Mn
36,1	7,2	16,5	16,2	19,8	0,8	3,9	0	0	326,2	12,6	83,2	80,5

Source: Funceme (2016).

The first application of treatments, with the respective dosages of bokashi that were 0, 3, 6, 9, 18 g.L-1 were performed with 15 days of transplantation. The second application of the fertilizer was carried out after 25 days, on December 8, 2015. The irrigation used was carried out by the automated system with inverted micro sprinklers, resulting in flow for each pot of 1mm of water per day (Figure 2).

Figura 2. Overview of treatments for basil cultivars.
Source: Silva, C. F. (2016).

The evaluations were carried out at 85 days after sowing. Plants were collected and identified for the evaluation of the following variables: plant height (cm), base diameter (mm), root length (cm), fresh mass of the aerial part and root (g), dry mass of the aerial part and root (g).

The treatments used were arranged in a randomized block design (RBD), arranged in a 2x5 factorial scheme, consisting of two cultivars of basil: Genovese and Anão, and five doses of Bokashi, namely: 0, 3, 6, 9 and 18 g.L^{-1}. Plants that received no dose (0 g.L^{-1}) served as a control treatment. Each treatment contained 5 repetitions, with the plot consisting of 7 pots, one plant per pot, the useful unit a pot with a basil seedling.

The results were submitted to analysis of variance using the Sisvar® statistical analysis software, version 5.3. Comparisons between substrates were performed using the Scott-Knoot test at the level of 5% probability. In assessing the effects of doses and the interaction between factors, regression analysis was used at the level of 0.01 (**) and 0.05 (*) of probability by the F test and the highest coefficient of determination (R^2). The Microsoft Office Excel 2007 program was used to make the graphs.

RESULTS AND DISCUSSION

Basil cultivars were significant in all variables with the exception of fresh shoot weight (MFPA). The dose factor was significant in all variables with the exception of root length (CR). The interaction between doses and cultivars was significant only in fresh root mass (MSRA) (Table 2).

Table 2. Summary of analysis of variance of plant height (PH), base stem diameter (BSD), root length (RL); fresh aerial part mass (FAPM), fresh root mass (FRM), dry aerial part mass (DAPM), and dry mass of the root part (DMRP) of two cultivars of basil depending on different doses of Bokashi. Fortaleza-CE, 2015.

		Medium Square						
Variation Source	GL	PH (cm)	BSD (mm)	RL (cm)	FAPM (g)	FRM (g)	DAPM (g)	DMRP (g)
(V)	1	196.66**	2.99**	47.41**	0.53^{ns}	5.10**	0.09*	0.25**
Doses (D)	4	93.55**	1.87**	6.33^{ns}	3.02**	0.64**	0.18**	0.02*
(V x D)	4	14.60^{ns}	0.23^{ns}	7.07^{ns}	0.21^{ns}	0.24*	0.2^{ns}	0.01^{ns}
Residue	27	6.55	0.13	5.36	0.16	0.88	0.02	0.01
CV (%)		24.1	16.57	19.02	24.43	28.83	29.26	29.42
Media		10.62	2.19	12.17	1.64	0.99	0.49	0.28

^{ns}- not significant; **,* - Significant to a 1% e a 5%, respectively by F test.

The Genovese cultivar was superior in practically all variables. With the exception of the base stem diameter, where the Anão cultivar was superior to that of Genovese with an average of 2.4648 cm (Table 3).

Table 3. Average plant height (PH), base stem diameter (BSD), root length (RL), fresh aerial part mass (FAPM), fresh root mass (FRM), dry aerial part mass (DAPM), and dry mass of the root part (DMRP) from two cultivars of basil as a function of different doses of Bokashi . Fortaleza, CE, 2015.

Cultivars	PH (cm)	BSD (mm)	RL (cm)	FAPM (g)	FRM (g)	DAPM (g)	DMRP (g)
Genovese	12.84 a	1.90 b	13.26 a	1.76 a	1.34 a	0.53 a	0.35 a
Anão	8.40 b	2.46 a	11.08 b	1.53 b	0.63 b	0.44 b	0.19 b

Means followed by equal letters do not differ, by the Scott-Knott test, at 5% significance.

According to Figure 3, it is possible to identify that the dose 9 g.L^{-1}, related to the value of 13,598 cm, provided a higher height for the plant in the Genovese cultivar, which may be due to the nitrogen (N) content in the bokashi that influenced it positively, allowing the increase in plant height. Cardoso, Viana, Matsumoto, Sediyama and Carvalho, (2005) points out that the action of nitrogen (N) favors the vegetative growth of the plant.

The Genovese cultivar showed a higher growth compared to the Anão cultivar, in view of its distinct botanical and genotypic characteristics. However, in view of the treatments with the doses of Bokashi used, based on the control treatments, an increase in height is observed in both cultivars, showing similar graphic behaviors (Figures 3 and 4).

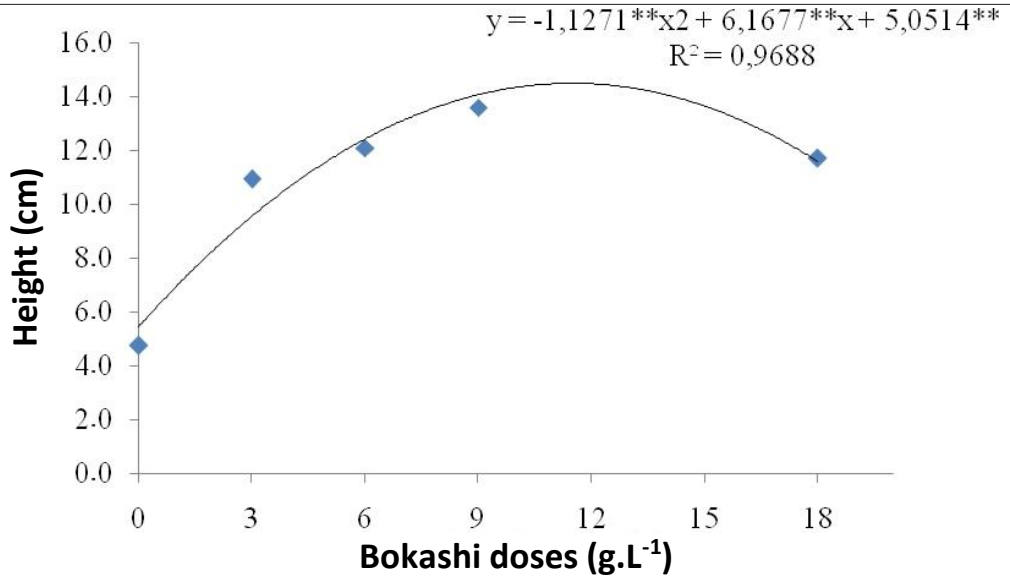

Figure 3. Height of the basil Genovese cultivar submitted to different Bokashi doses.

According to Marschner, (2011), nitrogen (N) influences most significantly the increase in leaf area, as it is directly related to the rate of expansion and cell division, being one of the main responsible for the final size of the leaves, where greater carbohydrates and amino acids synthesis occurs. This result is due to the effect of using the Bokashi compound, because when mixed with the residues, it accelerates and improves the degradation of organic matter, resulting in a quantity of liquid nitrogen rapidly available; however, the liquid nitrogen mineralization is affected by the high C/N ratio of the waste and the incubation time of the same (Boechat, Santos, & Accioly, 2013).

When it comes to the base stem diameter (Table 2 and Figure 4), the dose 9 g.L^{-1} showed the best average with 2.66 mm in diameter. According to Taiz and Zeiger (2012), this fact can be explained by the increased availability of nutrients in the soil, resulting in greater absorption and, consequently, greater accumulation of biomass. The larger diameter of the stem is a desirable characteristic in many vegetable species, since it helps support the aerial part and stores the reserves resulting from photosynthesis.

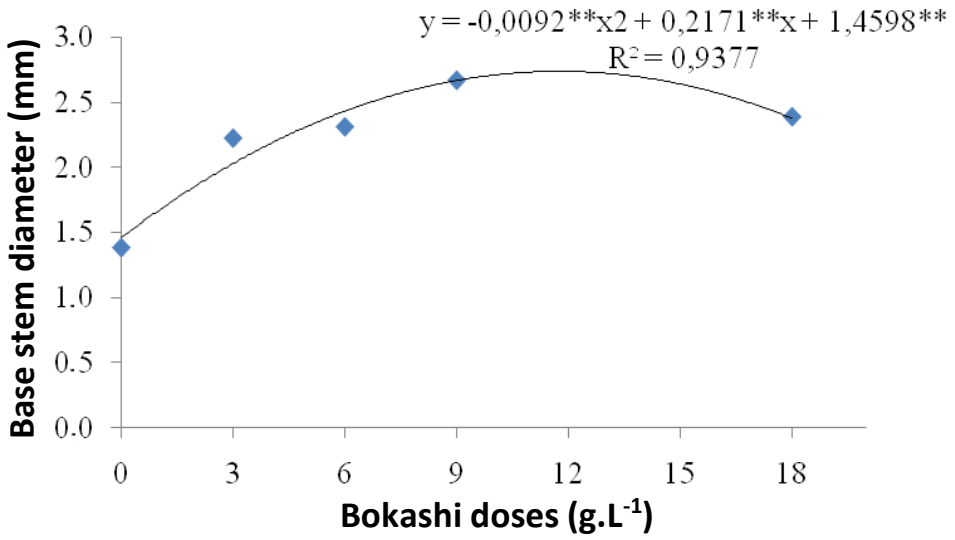

Figure 4. Base stem diameter of the basil Anão cultivar submitted to different Bokashi doses.

According to Souza, Oliveira, Martins Filho and Lima (2006), the base stem diameter is associated with a more accentuated development of the aerial part and especially the root system, thus favoring the growth of plants.

The use of bokashi did not influence the characteristic length of the root, which may be the

result of cultivation in pots, limiting the growth of the root system. Poorter, Bühler, Van Dusschoten, Climent and Postma (2012) found that plants grown in some type of container have a limited length of roots.

Table 3 shows the relationship between fertilizer doses and fresh root mass (FRM), where the 9 $g.L^{-1}$ dose showed better performance. The fresh matter of the aerial part, for both cultivars Genovese (upper curve) and Anão (lower curve), exhibited quadratic behavior in relation to the dosages until reaching a certain peak, in the dose of 9 $g.L^{-1}$ of Bokashi.

For the variable fresh mass of the aerial part (FAPM), we can see that it fits the linear regression model, with inverse results relative to the increase in Bokashi doses concentration after reaching the performance one (Figure 5).

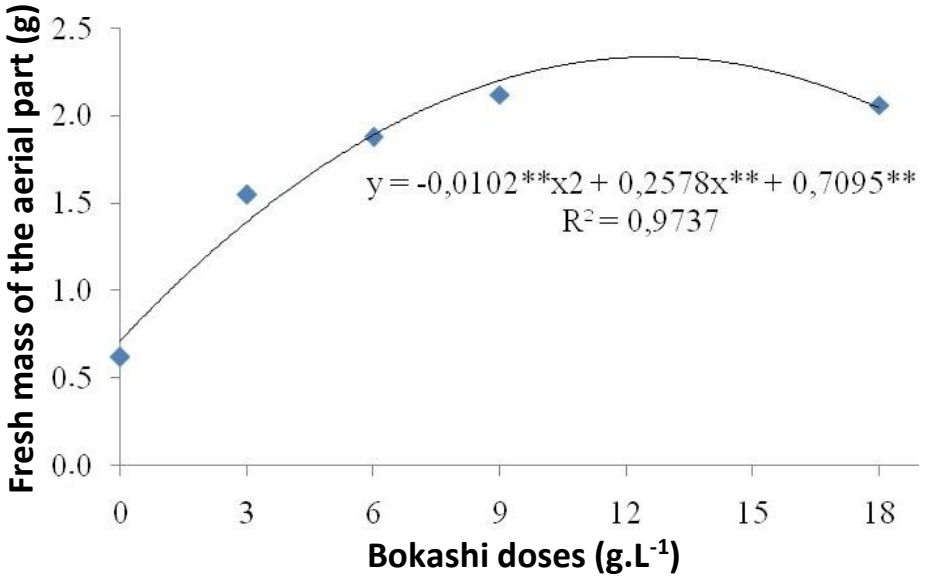

Figure 5. Fresh mass of the aerial part of basil Genovese cultivar submitted to different Bokashi doses.

Oliveira, Hernandez and Assis-Júnior (2008) found a significant effect of the levels of organic fertilization, with bovine manure, on the height of lettuce plants cultivar Elba. Regarding the dry mass of the aerial part (Figure 6), the two cultivars showed significant results, with the increase in the Genovese cultivar (0.54) superior to the Anão cultivar (0.44). Due to the difference in size of the tested cultivars, this data is secondary, given the relevance of relating them, in terms of results, with their respective control seedlings (zero dose).

In studies such as that of Pedrinho-Júnior, Bianco and Pitelli (2004), the accumulations of nutrients for each part of the plants were determined by multiplying the nutrient content by the corresponding dry mass, where it is thus valid to relate the increase in dry matter with the nutritional increase. This fact is relevant in view of the culinary use of basil. The crop yield depends on the production of total biomass and the distribution of dry mass between the productive and non-productive parts of the plant (Thomas, Barnes, Rankin, & Hole, 1983).

Figure 7 shows the average dry mass of the root part, where the Genovese cultivar had a greater accumulation of dry mass compared to the Anão cultivar, due to the difference in size and its botanical characteristics.

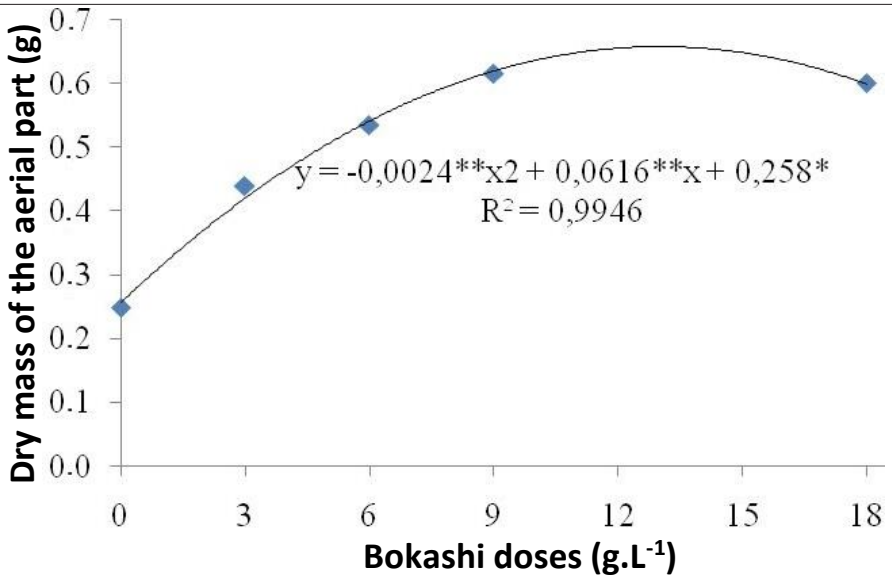

Figura 6. Dry mass of the aerial part of the basil Genovese cultivar submitted to different Bokashi doses.

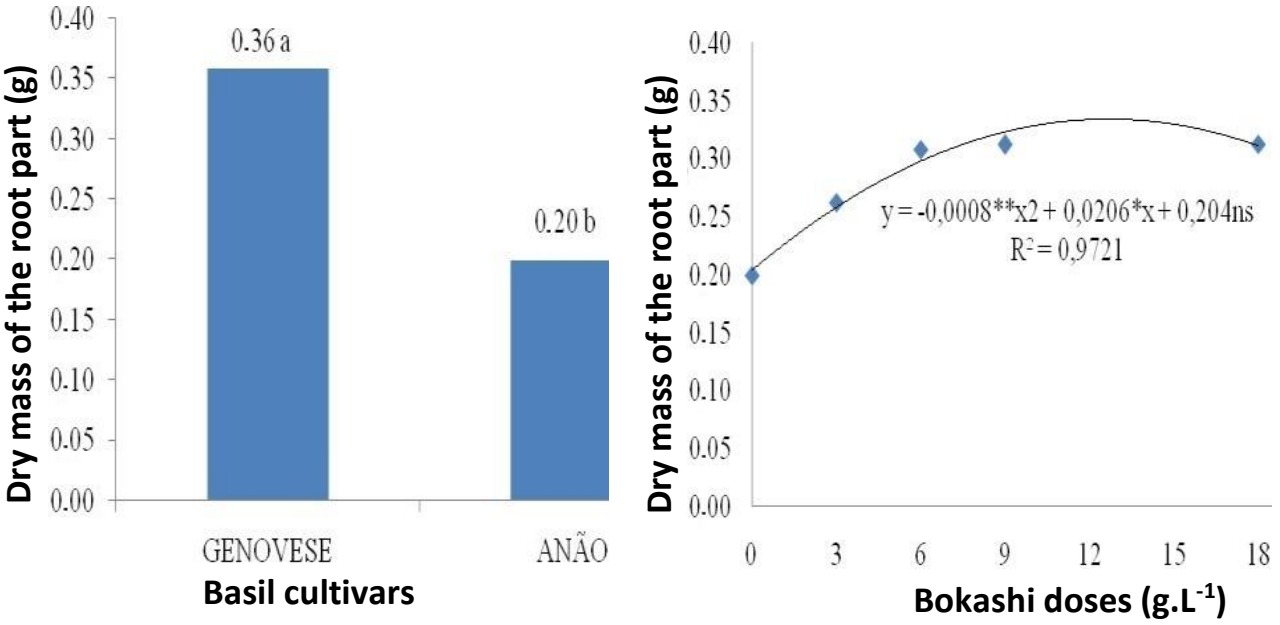

Figure 7. Dry mass of the root part of the Anão and Genovese cultivars submitted to different Bokashi doses.

The relationship between the doses of Bokashi and dry mass of the root part was significant, whose application was effective in the development of the two cultivars worked. In the graph we can see the increase in mass as the doses increased.

Studies such as Blank, Silva, and Silva-mann (2005), Carnevali et al. (2010), Costa et al (2008) and Moraes, Gonçalves-Junior, Nacke and Yoshihara (2014) confirm that the increase in mass and productivity and consequently the dry mass when effective sources of nutrients in any form either as readily available sources or in organic form to a maximum point, where from there, growth decreases due to the high level of nutrients.

CONCLUSIONS

Bokashi positively influenced the growth of basil in the two cultivars Genovese and Anão.

The 9 $g.L^{-1}$ dose of bokashi showed the most satisfactory results for the variables analyzed in the

basil cultivars.

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Received: October 7, 2020.
Accepted: October 26, 2020.
Published: March 1st, 2021.

English by: Roberto Jun Takane.