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Avaliação de resíduo orgânico de algodão e aplicação de bioestimulante na produção de rabanete (*Raphanus sativus*)

Evaluation of organic cotton residue and application of biostimulant in the production of radish (*Raphanus sativus*)

Evaluación de residuos orgánico de algodón y aplicación de bioestimulante en la producción de rábano (*Raphanus sativus*)

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Resumo

O objetivo desse trabalho foi avaliar o crescimento e a produção de rabanete em resposta a doses de resíduo de algodão e aplicação de bioestimulante. O delineamento experimental utilizado foi blocos casualizados, em esquema fatorial 5 x 2, utilizando as doses de 0; 25; 50; 75; 100 t ha^{-1} de resíduo de algodão e presença e ausência de bioestimulante, com três repetições. Aos 32 dias após emergência foram realizadas as determinações das variáveis: altura de planta, área foliar, diâmetro de raízes comerciais, diâmetro de raízes não comerciais, massa fresca de raízes comerciais, massa fresca de raízes não comerciais; massa seca de raízes; massa seca das folhas das plantas. Observaram-se aumentos variando de 49,74 até 1.291% dependo da variável analisada, comparando a testemunha com a maior dose de resíduo de 100 t ha^{-1}. Os tratamentos com aplicação do bioestimulante foram superiores até 25,75% em relação aos tratamentos sem aplicação. Conclui-se que aplicação de resíduo de algodão e bioestimulante são boas alternativas para melhorar o desempenho das plantas de rabanete e que podem ser utilizadas em sistemas de produção orgânica.

Palavras-chave: Adubo orgânico; Hormônio vegetal; Produtividade de olerícolas.

Abstract

The objective of this study was to evaluate the growth and yield of radishes in response to cotton residue doses and biostimulant application. The experimental design was in randomized blocks in a 5 x 2 factorial scheme using the doses of 0; 25; 50; 75; 100 t ha^{-1} of cotton residue with or without biostimulant, with three replicates. At 32 days after emergency, the following variables were determined: plant height, leaf area, diameter of commercial roots, diameter of non-commercial roots, fresh mass of commercial roots, fresh mass of non-commercial roots, root dry mass, and dry mass of the plant leaves. Increases ranging from 49.74 to 1.291% were observed depending on the analyzed variable in comparing the control with the highest residue dose of 100 t ha^{-1}. The biostimulant application treatments were up to 25.75% superior in relation to the treatments without application. It is concluded that cotton residue application and biostimulant are good alternatives to improve the performance of radish plants and can be used in organic production systems.

Keywords: Organic fertilizer; Plant hormone; Productivity of vegetables.

Resumen

El objetivo de este trabajo fue evaluar el crecimiento y la producción de rábano en respuesta a las dosis de residuos de algodón y la aplicación de bioestimulantes. El diseño experimental utilizado fue bloques al azar, en un esquema factorial de 5 x 2, utilizando dosis de 0; 25; 50; 75; 100 t ha^{-1} de residuo de algodón y presencia y ausencia de bioestimulante, con tres repeticiones. A los 32 días después de la emergencia, se determinaron las variables: altura de la planta, área de la hoja, diámetro de las raíces comerciales, diámetro de las raíces no comerciales, masa fresca de raíces comerciales, masa fresca de raíces no comerciales; masa de raíz seca; masa seca de hojas de plantas. Se observaron aumentos que varían de 49.74 a 1.291% dependiendo de la variable analizada, comparando el control con la dosis más alta de desechos de 100 t ha^{-1}. Los tratamientos con la aplicación del bioestimulante fueron hasta un 25,75% más altos que los tratamientos sin aplicación. Se concluye que la aplicación de residuos de algodón y bioestimulantes son buenas alternativas para mejorar el rendimiento de las plantas de rábano y que pueden usarse en sistemas de producción orgánica.

Palabras clave: Fertilizante orgánico; Hormona vegetal; Productividad de hortalizas.

1. Introduction

Radish (*Raphanus sativus* L.) roots are the part of commercial interest and their size depends on the amount of nutrients present in the soil, having its cultivation highlighted in metropolitan city green belts (Linhares et al., 2010). It is a fast growing plant and generates financial return to the producer in a short time, and can be harvested around 30 days after sowing, depending on the cultivar (Silva et al., 2012).

Due to its rapid development, this oleracea requires a great availability of nutrients in a short period of time, and nutritional problems are difficult to be solved during the plant cycle (Coutinho Neto et al., 2010). The most widely used way to provide this large amount of nutrients is through chemical fertilizers, but when poorly managed this modality increases production costs and can cause negative effects to the environment. In this way, many farmers have started to use alternatives such as organic fertilizers (Cecconello & Centeno, 2016).

Organic fertilization promotes a gradual release of nutrients, elevates the pH by increasing the nutrient retention capacity, increases the biological activity and also provides a greater diversity of nutrients as they present varying compositions according to the residue used (Naik et al., 2009). From the physical point of view, it improves soil structure, reduces plasticity and cohesion, increases water retention capacity and aeration, which allow greater root penetration and distribution (Pires et al., 2008). Another advantage is the use of waste that often has no suitable destination other than use by agriculture.

The demand for food produced in organic systems is increasing, and therefore several vegetable producers are converting their conventional production system into an organic system. However, they still find difficulties in organic fertilization management due to a lack of information regarding the composition and concentration of nutrients present in organic fertilizers, making it difficult to produce crops (Schallenberger et al., 2016). The waste may not have the amount of nutrients required by the crop to which it is applied and the nutrients offered by the organic fertilizer may vary according to the raw material used.

In this same line, one can also highlight the use of biostimulants as an alternative for establishing sustainable agricultural systems. Biofertilizers or stimulants are defined in Normative Instruction No. 46 of October 6, 2011, as products that contain active components or biological agents and are exempt from substances prohibited by organic regulation (MAPA, 2012). Biostimulants can be natural or synthetic substances used in soil, plants and seeds which modify vital and structural processes, aiming to increase productivity (Ávila et al., 2008).

Thus, the objective of this research was to evaluate the growth and yield of radishes in response to cotton residue doses and biostimulant application.

2. Methodology

A research is made to bring new knowledge for society as stated by Pereira et al. (2018). The experiment was conducted in a greenhouse at the Chapadão do Sul Campus Experimental Area, at the Federal University of Mato Grosso do Sul/MS located at coordinates (18° 46' 17.8" S, 52° 37' 27.7" W, 813 m altitude). Thirty black plastic pots with a capacity of five liters were used, in which Dystrophic Red-Yellow Latosol soil was added (Souza et al., 2013), collected from the 0.0-0.20 m layer. An analysis to characterize the initial condition of the soil used in the experiment was performed which had the following characteristics: pH in $CaCl_2$ = 5.3; soil organic matter = 25.8 g dm^{-3}; base saturation = 59.9%; CTC =8.5 $cmol_c$; P (mel) = 9.8 mg dm^{-3}; K^+ = 224 mg dm^{-3}; Ca^{2+} = 3.0 $cmol_c$ dm^{-3}; Mg^{2+} = 1.5 $cmol_c$ dm^{-3}; Al^{3+} = 0.03 $cmol_c$ dm^{-3}; H + Al^{3+} = 3.4 $cmol_c$ dm^{-3}; S = 2.7 mg dm^{-3}; B = 0.44 mg dm^{-3}; Cu (mel) = 0.5 mg dm^{-3}; Fe (mel) = 84 mg dm^{-3}; Mn (mel) = 14.6 mg dm^{-3}; Zn (mel) = 4.3 mg dm^{-3}; the soil texture was composed of 395 g dm^{-3} of clay, 75 g dm^{-3} of silt and 530 g dm^{-3} of sand.

The experimental design implemented a randomized complete block design in a 5 x 2 factorial scheme, with three replications. The treatments consisted of five cotton residue doses (0, 25, 50, 75, 100 t ha^{-1}) applied before sowing, associated with or without foliar application of 100 mL^{-1} of Stimulate por 100 L of water at eleven days after emergence (DAE). Stimulate® contains 0.09 g L^{-1} of kinetin (cytokinin), 0.05 g L^{-1} of gibberellic acid (gibberellin) and 0.05 g L^{-1} of indolebutyric acid (auxin).

Sowing was performed on January 10, 2017, at a depth of two centimeters, and six seeds were sown per pot. Thinning was performed fifteen days after sowing, leaving three plants per pot. These were irrigated twice a day by an automated sprinkler system.

The material used as organic fertilizer to compose the treatments was cotton residue composed of cotton plant structures such as leaves, stems and bark of the bush that are discarded in the cotton beneficiation process. This material remained piled up in a composting process for about two years. The obtained chemical composition was: pH in $CaCl_2$ = 6.6; moisture = 73.64%; organic carbon = 34.65%; N = 3.48%; C/N ratio = 9.96; P = 5.4 g kg^{-1}; K^{2+} = 20.2 g kg^{-1}; Ca^{2+} = 35.2 g kg^{-1}; Mg^{2+} = 5.8 g kg^{-1}; Cu = 16 mg kg^{-1}; S = 4.9 g kg^{-1}; Fe = 10838 mg kg^{-1}; Mn = 148 mg kg^{-1}; Zn = 72 mg kg^{-1} and B = 87 mg kg^{-1}.

At 32 DAE the radishes were harvested and the following variables were evaluated: PH - plant height (cm), determined with a ruler measured at a distance from the ground level to the end of the highest leaf; LA - leaf area (cm^2), determined with a CI-203 leaf area meter, using all the plant leaves; DCR - diameter of commercial roots (mm), DNCR - diameter of non-commercial roots (mm), FMCR - fresh mass of commercial roots (g), FMNCR - fresh mass of non-commercial roots (g); RDM - root dry mass (g); LDM - plant leaves dry mass (g).

The dry mass of leaves and roots was obtained after drying in an oven, with forced circulation of air and temperature regulated at 65ºC until reaching constant mass, expressed in g $plant^{-1}$. The roots were divided into commercial and non-commercial roots after determining the diameters using a digital caliper (expressed in mm); commercial roots were considered as those with diameter greater or equal to 20 mm. The fresh masses of commercial and non-commercial roots were determined after weighing on a precision scale, expressed in g $plant^{-1}$.

Data were submitted to analysis of variance using the Sisvar 5.3 statistical program (Ferreira, 2014). The qualitative factor of using or not using biostimulant was compared by the Tukey test at 5% probability. The quantitative factor of cotton manure doses was submitted to regression analysis, also at 5% probability.

3. Results and Discussion

There was a significant interaction between treatments for the analyzed variables: leaf area, leaf dry mass, commercial and non-commercial root diameter, fresh commercial and non-commercial root mass, root dry mass (Table 1).

Table 1. Average values of leaf area per plant (LA), plant height (PH), leaf dry mass (LDM), diameter commercial (DCR) and non-commercial (DNCR) radish root, fresh commercial (FMCR) and non-commercial (FMNCR) radish root mass, root dry mass (RDM) of according to cotton residue (CR) doses and biostimulant (BIO) use. Chapadão do Sul, MS, UFMS, 2017.

		Mean square values							
Var.	GL	LA	PH	LDM	DCR	DNCR	FMCR	FMNCR	RDM
Repet.	2	9.68	0.11	0.008	2.64	0.61	0.04	0.003	0.005
CR	4	249863**	70.01**	0.85**	942**	79.03**	322**	14.43**	0.62**
BIO	1	22538**	12.98**	0.13**	213**	67.53**	24.75**	9.78**	0.07**
CRxBIO	4	2020**	0.96^{ns}	0.01**	33**	6.15**	2.16**	0.40**	0.02**
Residue	18	30.27	0.77	0.0009	4.07	0.51	0.18	0.03	0.004
CV	-	1.01	4.12	3.73	10.28	7.83	4.25	5.16	11.62
Average	-	544.97	21.39	0.83	19.65	9.15	10.05	3.38	0.60

** 1% probability. Source: prepared by the authors

For the leaf area (Figure 1A), it was verified that the treatment with biostimulant application was superior to the treatment without application, and the increment was 11.62% in comparing these treatments to the greater residue dose.

This increase may have occurred due to the addition of gibberellin in the plant after the biostimulant application. Gibberellin participates in cell division and shoot growth (Taiz et al., 2017).

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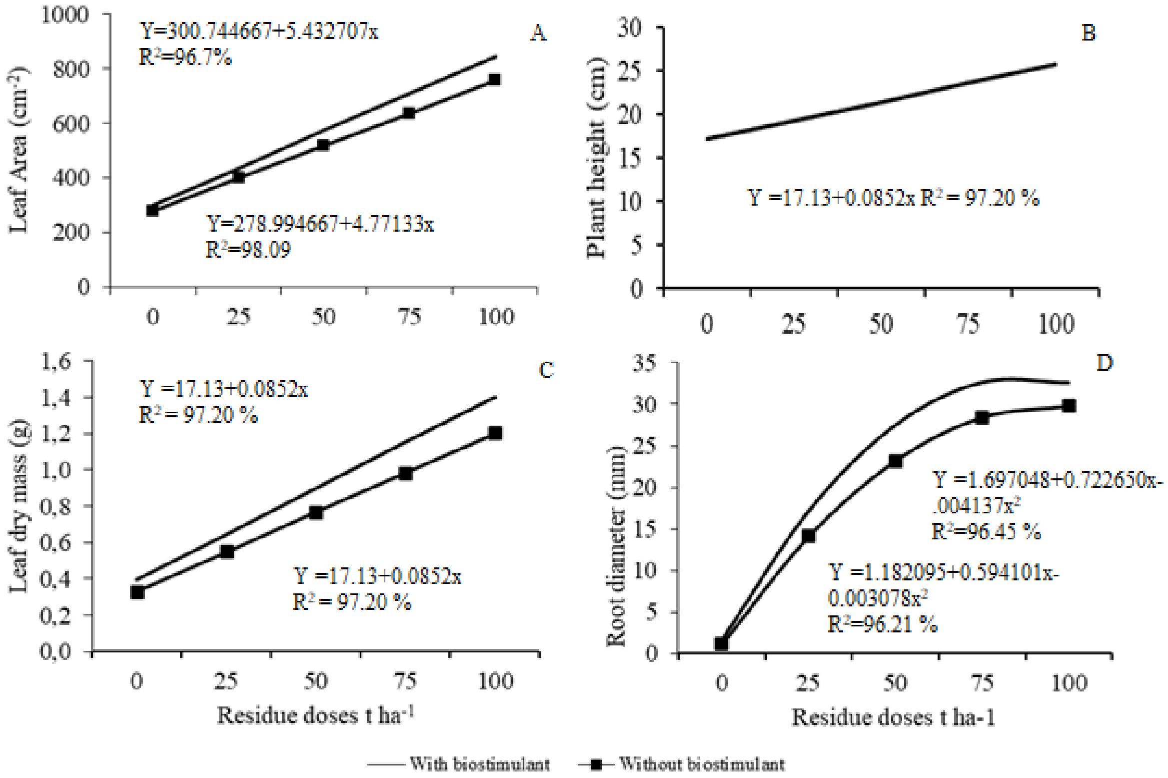
Figure 1. Radish leaf area (A), plant height (B), leaf dry mass per radish plant (C) and commercial root diameter per plant (D) of according to cotton residue doses and biostimulant use.

Source: prepared by the authors.



Source: Authors.

There was a linear increase in the plants' leaf area with the increase in the residual doses, and the increase was 181% in comparing the control with the highest residue dose and the biostimulant application. The leaf area is important because this is the plant organ where photosynthesis occurs, being responsible for the photoassimilate production that will be directed to the productive organs of the plant (Linhares et al., 2010). As highlighted by Coutinho Neto et al. (2010), when more fresh shoot mass is produced, higher amounts of nutrients are stored.

There was no significant interaction between the treatments for the plant height variable, but there was a linear increase for this variable with the increase of the residual doses (Figure 1B). The increase was 49.74% in comparing the control with the highest residue dose. Pereira et al. (2011) observed that treatment with earthworm humus accentuated the height growth of radish plants with linear behavior. Taiz et al. (2017) stated that good soil fertility conditions increase cytokinin levels, favoring shoot growth. Plant heights were also influenced by biostimulant application (Table 1), and the treatment with biostimulant was superior when compared to without application, having a height increase corresponding to 6.37%.

For the leaf dry mass variable (Figure 1C), it was observed that the treatments with biostimulant application were superior to the treatments without application, and that the increment was 16.67% in comparing these treatments with the greater residue dose. There was a linear increase in the leaf dry mass with the increase in the residue doses, with the increment being 324.24% in comparing the control with the greater residue dose and biostimulant application. Queiroz et al. (2011) tested different doses of swine biofertilizer in radish plants and verified that the fresh shoot biomass better adjusted to linear regression. According to Góes et al. (2011), the improvement in these variables with increasing amounts of residue probably occurred through the nutrient availability provided by the decomposition and mineralization dynamics of the incorporated material.

The commercial root diameter (Figure 1D) in the treatment with the biostimulant application was superior to the diameters of the treatment without application, obtaining an increase of 18.72% in comparing these treatments in the greater residue dose. Gibberellic acid and cytokinin hormones, which are in the composition of biostimulants, are responsible for cell division, promoting differentiation of meristematic cells and inducing differentiation in phloem and xylem (Taiz et al., 2017), which may promote greater root diameter.

In the absence of residue and at the dose of 25 t ha^{-1}, there was no commercial root production, since all the roots produced in these treatments had a diameter smaller than 20 mm. With the increase in the residue doses, root diameters increased up to the 87.34 t ha^{-1} dose for biostimulant treatments, after which there was stagnation in the diameters. For the treatments without biostimulant the diameters increased until the residue dose of 96.51 t ha^{-1}. Carneiro et al. (2013) suggest that only a small portion of the nitrogen is released during the crop cycle, since its availability is conditioned to the process of mineralization of organic matter.

For non-commercial root diameter (Figure 2A), it was observed that the treatment with biostimulant application was superior to the treatments without application, and that the increment was of 25.75% in comparing these treatments in the greater residue dose.

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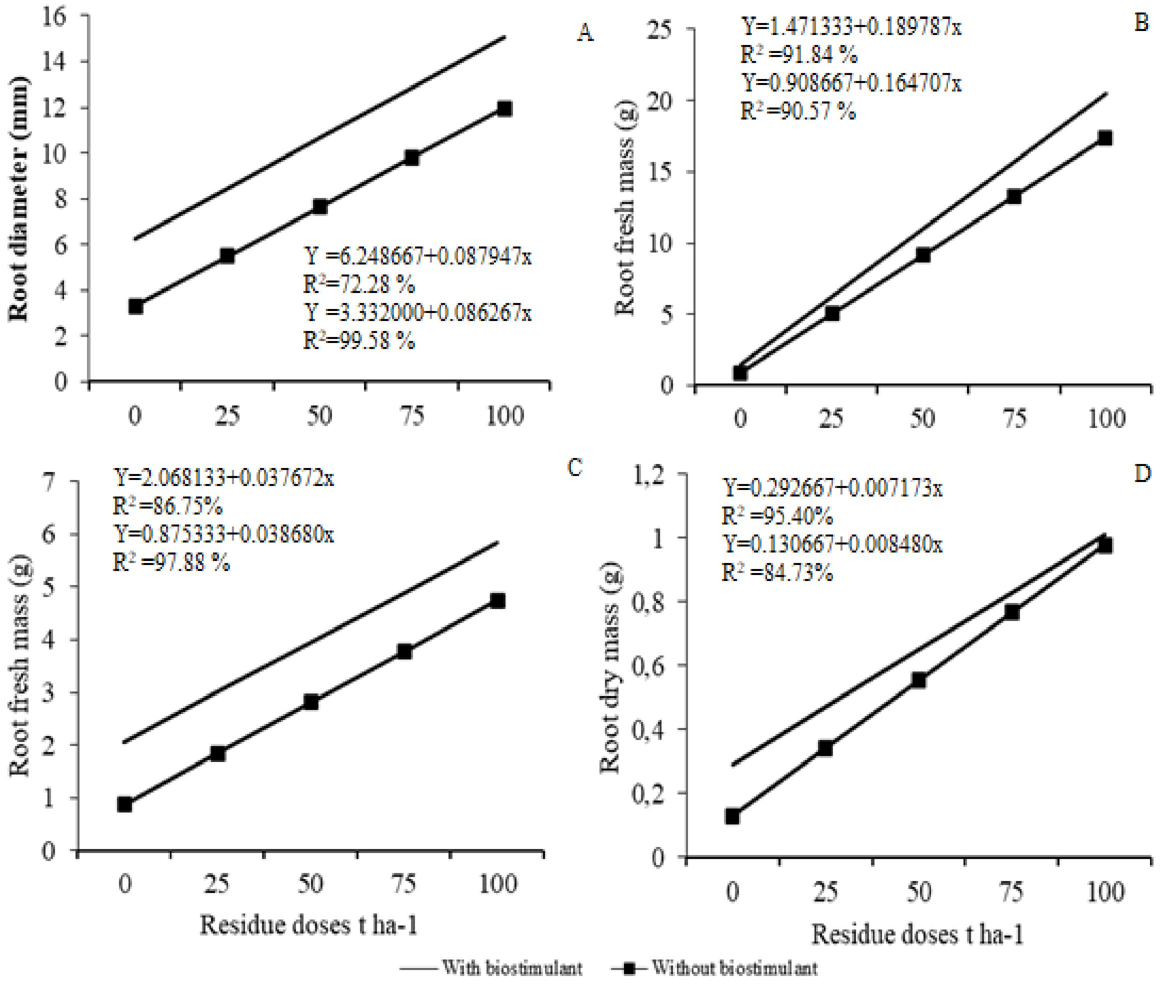
Figure 2. Diameter of non-commercial roots per plant (A), fresh mass of commercial roots per plant (B), fresh mass of non-commercial roots per plant (C) and root dry mass in grams per plant of according to cotton residue doses and biostimulant use.



Source: prepared by the authors.

There was a linear increase in non-commercial root diameter with the increase of residue doses, and the increase was of 140.64% in comparing the control with the highest residue dose and biostimulant application. Pimentel, De-Polli and Lana (2009) analyzed the nutrient concentration in the soil in two experiments with organic compost and reported that it was the low availability of N that limited the yield of radishes with organic fertilization, since the authors observed that other nutrients of P, K, Ca and Mg were available to the plants on the first day after planting, and that maximum availability occurred 6 days after planting the crops.

For commercial root fresh mass (Figure 2B), it was observed that the treatments with biostimulant application were superior to the treatments without application, and that the increment was of 17.66% in comparing these treatments in the greater residue dose. Silva et al. (2008) reported that these products favor plants, causing changes in vital and structural processes, promoting hormonal balance and stimulating root system development.

There was a linear increase in fresh commercial root mass with increasing doses of residue (Figure 2B), and the increase was 1,291.16% in comparing the control with the highest residue dose and biostimulant application. The use of the residue promotes an increase in soil organic matter. The organic carbon present in organic matter is essential for the sustainability of agriculture, as it stimulates the soil microbiota thereby increasing the efficiency of nutrient utilization, generally providing higher crop productivity (Paul et al., 2013). The organic matter benefits the physical conditioning of the soil, the buffering effect, thermal control and better water retention (Boulal et al., 2011).

In analyzing the fresh mass of non-commercial root (Figure 2C), it was observed that the treatment with biostimulant application was superior to the treatment without application, and that the increase was of 23.21% in comparing these treatments in the greater residue dose. Biostimulants stimulate root growth and improve plant development, since they are considered metabolic activators (Bezerra et al., 2007).

There was a linear increase in the fresh mass of non-commercial roots with the increase in the residue doses, being that the increment was 182.12% in comparing the control with the greater residue dose and biostimulant application. Cecílio Filho, Rezende & Canato (2007) state that root size depends on soil fertility and other factors. The lack of nutrients may be one of the causes of the presence of non-commercial roots in the treatments.

In the variable root dry mass (Figure 2D), it was verified that the treatment with biostimulant application was superior to the treatment without application. Dantas et al. (2012) reported that applying growth regulators promotes root growth, rapid establishment, uniform plant growth, improved nutrient uptake and yield, contributing to the increase in root dry mass.

There was a linear increase in the root dry mass with the increase in the residual doses, and the increment was 248.27% in comparing the control with the highest residue dose and biostimulant application. Organic fertilizers improve the biological aspects of the soil, increasing the biodiversity of useful microorganisms that act in solubilizing fertilizers acting in the release of nutrients for the plants (Araújo et al., 2014).

4. Final Considerations

The search for inputs capable of improving crop productivity is a current dynamic in agriculture. It was found that the use of cotton residues and biostimulant in this radish crop provided considerable gains in growth and yield and may be of significant support in producing mainly organic or low investment producers since it does not consider chemical fertilization.

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References

Araújo, DL, Véras, MLM, Alves, LS, Andrade, AF & Andrade, R. (2014). Efeito de fertilizante á base de urina de vaca e substratos em plantas de pimentão. *Pesquisa Agropecuária Tropical* 4(2): 173-185.

Ávila, MR, Braccini, AL, Scapim, CA, Albrecht, LP, Tonin, TA & Stulp, M. (2008). Bioregulator application, agronomic efficiency, and quality of soybean seeds. *Scientia Agricola* 65(6): 604-612.

Bezerra, PSG, Grangeiro, LG, Negreiros, MZ & Medeiros, JF. (2007). Utilização de bioestimulante na produção de mudas de alface. *Científica* 35(1): 46-50.

Boulal, H, Gómez-Macpherson, H, Gómez, JA & Mateos, L. (2011). Effect of soil management and traffic on soil erosion in irrigated annual crops. *Soil & Tillage Research* 115: 62–70.

Carneiro, WJO, Silva, CA, Muniz, JA & Savian, TV. (2013). Mineralização de nitrogênio em Latossolos adubados com resíduos orgânicos. *Revista Brasileira de ciências do solo* 37(3): 715-25.

Cecconello, ST & Centeno, LN. (2016). Avaliação de diferentes dosagens de vermicomposto produzido a partir de frutas, legumes e verduras na produção de rabanete (*Raphanus sativus L.*). *Thema* 13(1): 93-102.

Cecílio Filho, AB, Rezende, BLA & Canato, GHD. (2007). Produtividade de alface e rabanete em cultivo consorciado estabelecido em diferentes épocas e espaçamentos entre linhas. *Revista Horticultura Brasileira* 25(1): 15-19.

Coutinho Neto, AM, V. Orioli Jr, V, Cardoso, SS & Coutinho ELM. (2010). Produção de matéria seca e estado nutricional do rabanete em função da adubação nitrogenada e potássica. *Nucleus* 7(2): 105-114.

Dantas, ACVL, Queiroz, JM, Vieira, EL & Almeida, VO. (2012). Effect of gibberellic acid and the bioestimulant Stimulate® on the initial growth of thamarind. *Revista Brasileira de Fruticultura* 34(1): 8-14.

Ferreira, DF. (2014). Sisvar: a Guide for its Bootstrap procedures in multiple comparisons. *Ciência e Agrotecnologia* 38(2): 109-112

Góes, SB, Bezerra Neto, F, Linhares, PCF, Góes, GB & Moreira, JN. (2011). Productive performance of lettuce at different amounts and times of decomposition of dry scarlet starglory. *Ciência Agronômica* 42(4): 1036-1042.

Linhares, PCF, Pereira, MFS, Oliveira, BS, Henriques, GPSA & Maracaja, PG. (2010). Produtividade de rabanete em sistema orgânico de produção. *Revista Verde de Agroecologia e Desenvolvimento Sustentável* 5(5): 94-101.

MAPA. (2012). *Instrução Normativa, 46. Estabelece o Regulamento Técnico para os Sistemas Orgânicos de Produção Animal e Vegetal*. Ministério da Agricultura, Pecuária e Abastecimento (MAPA). Acesso em 18 de março em http://aao.org.br/aao/pdfs/legislacao-dos-organicos/instrucao-normativa-n46.pdf.

Naik, SK, Bharathi, TU, Barman, D, Devadas, R, Ram, P & Medhi, RP. (2009). Status of mineral nutrition of orchid: a review. *Journal of Ornamental Horticulture* 12(1): 1-14.

Paul, BK, Vanlauwe, B, Ayuke, F, Gassner, A, Hoogmoed, M, Hurisso, TT, Koala, S, Lelei, D, Ndabamenyet, T, Six, J & Pulleman, MM. (2013). Medium-term impact of tillage and residue management on soil aggregate stability, soil carbon and crop productivity. *Agriculture, Ecosystems and Environment* 164: 14-22.

Pereira, KS, Santos, CHB, Nascimento, WA, Armond, C, Silva, F & Casa, J. (2011). Crescimento de rabanete (*Raphanus sativus L.*) em resposta a adubação orgânica e biofertilizantes em ambiente protegido. *Horticultura Brasileira* 29: S4414-S4420.

Pereira, AS et al. (2018). *Metodologia da pesquisa científica*. [*e-book*]. Santa Maria. Ed. UAB/NTE/UFSM. Acesso em: 16 maio 2020. Disponível em: https://repositorio.ufsm.br/bitstream/handle/1/15824/Lic_Computacao_Metodologia-Pesquisa-Cientifica.pdf?sequence=1.

Pimentel, MS, De-Polli, H &. Lana, AMQ. (2009). Atributos químicos do solo utilizando composto orgânico em consórcio de alface-cenoura. *Pesquisa Agropecuário Tropical* 39(3): 225-32.

Pires, AA, Monnerat, PH, Marciano, CR, Pinho, LGR, Zampirolli, PD, Rosa, RCC. & Muniz, RA. (2008). Efeito da adubação alternativa do maracujazeiro amarelo nas características químicas e físicas do solo. *Revista Brasileira Ciência do Solo* 32(5): 1997-2005.

Queiroz, TB, Torres, WGA, Barros, RE, Parreiras, NS, Martins, ER & Colen, F. (2011). Produtividade de rabanete cultivado sob doses de biofertilizante suíno. *Cadernos de Agroecologia* 6(2): 1-5.

Schallenberger, E, Cantú, RR, Haro, MM, Morales, RGF & Heinzen, J. (2016). Método e Dose de Adubação de Hortaliças com Composto Orgânico em Sistema Orgânico de Produção. *Cadernos de Agroecologia* 11(2).

Silva, LFO, Campos, KA, Morais, AR, Cogo, FD & Zambon, CR. (2012). Tamanho ótimo de parcela para experimentos com rabanetes. *Revista Ceres* 59(5): 624-629.

Silva, TTA, Von Pinho, EVR, Cardoso, DL & Ferreira, CA. (2008). Qualidade fisiológica de sementes de milho na presença de bioestimulantes. *Ciência e Agrotecnologia* 32(3): 840-846.

Souza, EJ, Cunha, FF, Magalhães, FF, Silva, TR, Borges, MCRZ & Roque, CG. (2013). Métodos para estimativa da umidade do solo na capacidade de campo. *Revista de Ciências Agro-Ambientais* 11(1): 43-50.

Taiz, L, Zeiger, E, Moller, IM & Murphy, A. (2017). *Fisiologia e desenvolvimento vegetal*. Porto Alegre: Artmed.

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