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Uso de resíduo da indústria sucroalcooleira para a produção de mudas de quiabo

Use of waste from the sugar alcohol industry for the production of okra seedlings

Uso de residuos de la industria del alcohol azúcar para la producción de plantas de okra

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Resumo

A torta de filtro é um resíduo da indústria de processamento da cana-de-açúcar e tem apresentado ótimos resultados para sua utilização na adubação de culturas agrícolas. O objetivo desse trabalho foi avaliar o crescimento e desenvolvimento de mudas de quiabeiro produzidas com diferentes proporções de torta de filtro como substrato. O experimento foi conduzido em condições de casa de vegetação em delineamento experimental inteiramente casualizado (DIC) com cinco tratamentos e cinco repetições (5x5). Os tratamentos consistiram em cinco proporções para o preenchimento dos tubetes com torta de filtro de 0, 25, 50, 75 e 100%. A torta de filtro foi obtida em uma indústria sucroalcooleira próximo ao município de Santa Helena de Goiás. Foi avaliado a altura de plantas (AP), diâmetro de caule (DC), número de folhas (NF), comprimento de raiz (CR), massa fresca aérea (MFA), massa fresca da raiz (MFR), massa seca aérea (MSA) e a massa seca da raiz (MSR). Os dados foram submetidos à análise da variância pelo teste F ($p<0,05$) e em casos de significância, foi realizada análise de regressão para as proporções de torta de filtro, utilizando o software estatístico SISVAR. A adubação com torta de filtro em mudas de quiabo foi significativa ao nível de 5% de probabilidade para o CR e a 1% de probabilidade para AP, DC, NF, MFA, MFR, MAS, MSR. A máxima AP, DC, NF, CR, MFA, MFR, MAS, MSR foi obtido com as proporções de torta de filtro de 55,83; 49,58; 35,55; 47,25; 50,17; 48,5; 58,5 e 45,00%. O uso de resíduos da indústria sucroalcooleira pode ser utilizado para a adubação de mudas de quiabo. É recomendada a utilização da proporção de 55% de torta de filtro e 45% de solo, nessa dose as mudas de quiabo apresentam o melhor crescimento e desenvolvimento.

Palavras-chave: Resíduos agroindustriais; Ciclagem de nutrientes; Reaproveitamento.

Abstract

The filter cake is a residue from the sugarcane processing industry and has shown excellent results for its use in fertilizing agricultural crops. The objective of this work was to evaluate the growth and development of okra seedlings produced with different proportions of filter cake as a substrate. The experiment was carried out under greenhouse conditions in a completely randomized design (CRD) with five treatments and five replicates (5x5). The treatments consisted of five proportions for filling the tubes with 0, 25, 50, 75 and 100% filter cake. The filter cake was obtained in a sugar and alcohol industry near the municipality of Santa Helena de Goiás. Were evaluated plant height (PH), stem diameter (SD), number of leaves (NL), root length (RL), aerial fresh mass (AFM), fresh root mass (FRM), aerial dry mass (ADM) and the dry root mass (DRM). The data were submitted to analysis of variance by the F test ($p < 0.05$) and in cases of significance, regression analysis was performed for the filter cake proportions, using the SISVAR statistical software. The fertilization with filter cake on okra seedlings was significant at the level of 5% probability for the RL and 1% probability for PH, SD, NL, AFM, FRM, ADM, DRM. The maximum PH, SC, NL, RL, AFM, ADM, DRM was obtained with the filter cake proportions of 55.83; 49.58; 35.55; 47.25; 50.17; 48.5; 58.5 and 45.00%. The use of residues from the sugar and alcohol industry can be used for fertilizing okra seedlings. It is recommended to use the ratio of 55% filter cake and 45% soil, in that dose the okra seedlings show the best growth and development.

Keywords: Agro-industrial waste; Nutrient cycling; Reuse.

Resumen

La torta de filtro es un residuo de la industria de procesamiento de la caña de azúcar y ha mostrado excelentes resultados para su uso en la fertilización de cultivos agrícolas. El objetivo de este trabajo fue evaluar el crecimiento y desarrollo de plántulas de okra producidas con diferentes proporciones de torta de filtro como sustrato. El experimento se llevó a cabo en condiciones de invernadero en un diseño completamente al azar (DIC) con cinco tratamientos y cinco repeticiones (5x5). Los tratamientos consistieron en cinco proporciones para llenar los tubos con 0, 25, 50, 75 y 100% de torta de filtro. La torta de filtro se obtuvo en una industria azucarera y de alcohol cerca del municipio de Santa Helena de Goiás, se evaluó la altura de la planta (AP), el diámetro del tallo (DT), el número de hojas (NH), la longitud de la raíz (LR). masa fresca aérea (MFA), masa de raíz fresca (MRF), masa seca aérea (MSA) y masa de raíz seca (MRS). Los datos se sometieron al análisis de varianza mediante la prueba F ($p < 0.05$) y, en casos significativos, se realizó un análisis de regresión para las proporciones de la torta de filtro, utilizando el software estadístico SISVAR. La fertilización con torta de filtro en plántulas de quingombó fue significativa a un nivel de 5% de probabilidad para el LR y 1% de probabilidad para AP, DT, NH, MFA, MRF, MSA, MRS. El AP, DT, NH, LR, MFA, MRF, MSA, MRS máximos se obtuvo con las proporciones de torta de filtro de 55,83; 49,58; 35,55; 47,25;

50,17; 48,5; 58.5 y 45.00%. El uso de residuos de la industria del azúcar y el alcohol se puede utilizar para fertilizar las plántulas de okra. Se recomienda usar la proporción de 55% de torta de filtro y 45% de tierra, en esa dosis las plántulas de okra muestran el mejor crecimiento y desarrollo.

Palabras clave: Residuos agroindustriales; Ciclo de nutrientes; Reutilización.

1. Introduction

Okra Abelmoschus esculentus (L.) Moench, is one of the family Malvaceae plant originating from the African continent, is a very cultivated plant in the humid tropics due to favorable climatic conditions (Gemede et al 2015; Santos et al. 2020). The fruit of okra is rich in proteins, potassium, calcium, iron, phosphorus, vitamins A and B and 30% of the recommended levels of Vitamin C (Gemede et al 2014; Adekiya et al 2019), however, their production is important to food security and part of the food from various locations (Adekiya et al. 2019).

Okra is suitable for cultivation in family farming properties for itself as well as on a commercial scale consumption on average fruit yield ranges from 15 to 20 tons per hectare (Sediyama et al. 2009). In general, the spread is by cuttings, which are produced when properly ensures greater performance, health, plant population and less time to start of production.

The production of seedlings is one of the most important steps of the production system, the use of containers (tubes) with substrates to replace soil use have provided substantial increases in the quality of plants (Goncalves et al. 2018). The use of quality substrate ensures a higher rate of germination and growth rate, has the function to provide nutrients and increases the water retention capability.

In order to develop a more sustainable, clean agriculture, the use of organic waste as a source of nutrients and organic matter to agricultural production has a major environmental and economic impact. However, any change in the substrate composition results in a reduction of the performance of the seedlings and subsequently productivity of the crops. In general, a good substrate should contain adequate amounts of organic material, good water retention and adequate levels of nutrients. It has been observed that substrates with excess nutrients may have phytotoxic effects (Farias et al. 2019).

The filter cake is a waste of the processing of sugarcane industry and has shown excellent results for use in the fertilization of agricultural crops (Caioni et al. 2018). This organic waste is obtained from the process of clarification of sugar and milled bagasse per ton

of sugarcane processed, estimated to produce approximately 30 to 40 kg filter cake (Rocha et al. 2019). One of the advantages of using the filter cake as substrate is the reduction in production cost (Schmidt Filho et al. 2016), apart from being a viable product for replacement of chemical fertilization, the high concentration of macroelements such as nitrogen, phosphorus and potassium. Therefore, the objective of this study was to evaluated the growth and development of okra seedling produced with diferent proportional of filter cake as a substrate.

2. Methodology

The methodology used was an experimental field research of a qualitative nature. Data collection was performed by sampling with observation techniques and measurements in the field and analyzed by statistical method. The experiment was carried out in conditions of vegetation in the experimental area of the State University of Goiás, in the municipality of Santa Helena de Goiás, location coordinates are 17° 49' 34.3" S and 50° 36' 24.4" W with altitude of 570 m. According to Köppen (2013), the local climate is Aw, tropical, with rain in the months from October to April and dry from May to September. The maximum temperature ranges from 35 to 37 °C, and a minimum of 12 to 15 °C. The annual rainfall reaches 1800 mm approximately, however poorly distributed throughout the year.

The experimental design was a randomized (CRD) with five treatments and five repetitions (5x5) a total of 25 plots. The treatments consisted of five ratios for filling tubes with filter cake of 0, 25, 50, 75 and 100%. The filter cake was obtained in a sugar industry near the town of Santa Helena Goiás nutrient concentrations of the filter cake were Nitrogen (N) 17 g kg-1, phosphorus pentoxide (P_2O_5) 32 g kg-1 and potassium oxide (K_2O) 17 g kg^{-1}. The treatments were determined according to the research found by Barros et al. (2014) and Santana et al. (2012), who used the filter cake to produce vegetables.

As the filter cake contains nutrients essential to the development of plants, it was proposed to replace it with commercial substrates for the production of seedlings. Commercial substrates associated with alternative substrates have been used in research such as that of Almeida et al. (2017) and Medeiros et al. (2018). Therefore, from these researches it was proposed to replace the substrate with filter cake partially and completely for the production of okra seedlings.

The experiment started on 08/02/2015 and seedling evaluations were carried out 30 days after emergence. O The variety of okra chosen to be deployed in the experiment was the

Santa Cruz (SAKATA). The seedlings okra were produced in tubes of trays made from non-toxic polypropylene, with dimensions of 163 mm diameter and 190 mm in length, filled with filter cake proportions (0, 25, 50, 75 and 100%) the remainder of cartridge was filled with soil. Before sowing performed the irrigation trays and later were sown three seeds per cell in each cartridge.

After sowing the trays placed in a greenhouse with a 50% permeability to light, they were placed on a suspended structure 1 m from ground level. The emergency began three days after sowing, irrigation was performed three times a day with uniform blade on the trays and avoiding excess water. Thinning was performed five days after emergence, leaving only one seedling per tube. The evaluations were performed after 30 days of emergency when the seedlings had already transplanting conditions in the field.

It was evaluated plant height (PH) using tape, since the soil surface to the tip of the aerial part of the plant; stem diameter (SD) was determined using a caliper on the plant base, close to the ground surface; the number of leaves (NL), with fully expanded leaves count; Root length (CR), using tape. For reviews of aerial fresh weight (AFM) and fresh root weight (MFR), the plants were removed from the tubes and cut the stem base separating roots and shoots after each structure of the plant was weighed on an analytical balance. As for the dry air mass (MSA) and root dry mass (MSR), the structures were subjected to drying in a forced air oven at 65 °C for 48h, after it was weighed on an analytical balance. The variables were selected and the information collected as performed by Medeiros et al. (2018) for okra plants.

After data collection and tabulation, statistical software was used SISVAR® proposed by Ferreira (2011) for statistical analysis. The data for the variables were submitted to analysis of variance by F test ($p < 0.05$) and in cases of significance, regression analysis was performed for the filter cake proportions.

3. Results and Discussion

The fertilization with filter cake in okra seedlings was significant at the 5% probability level for the root length (RL) and 1% probability for plant height (PH), stem diameter (SD), number of leaves (NL), aerial fresh weight (AFM), fresh root weight (FRM), shoot dry weight (DRM) and dry root mass (MSR) (Table 1). Effect of the okra organic fertilizer variables growth has been observed by several authors (Passos et al, 2014; Santos et al 2018).

Table 1. Summary of the analysis of variance for plant height variable (PH); diameter stem (SD), leaves number (NL), root length (RL), aerial fresh mass (AFM), fresh root mass (FRM), aerial dry mass (ADM) and root dry mass (MSR) okra seedlings fertilized with different proportions of filter cake.

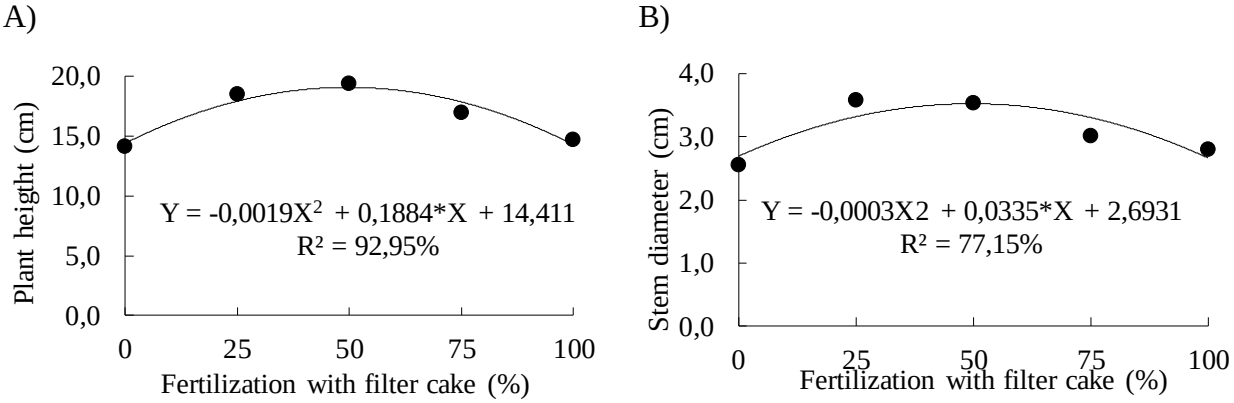
FV	DF	QM							
		PH	SD	NL	RL	AFM	FRM	ADM	DRM
Fertilizing[1]	4	26.41**	1.01**	2.14**	25.68*	2.64**	3.53**	0.21**	0.05**
Residue	20	3.16	0.07	0.24	7.79	0.05	0.12	0.001	0.001
CV (%)	-	10.63	9.07	17.25	13.19	11.26	13.10	10.26	14.57

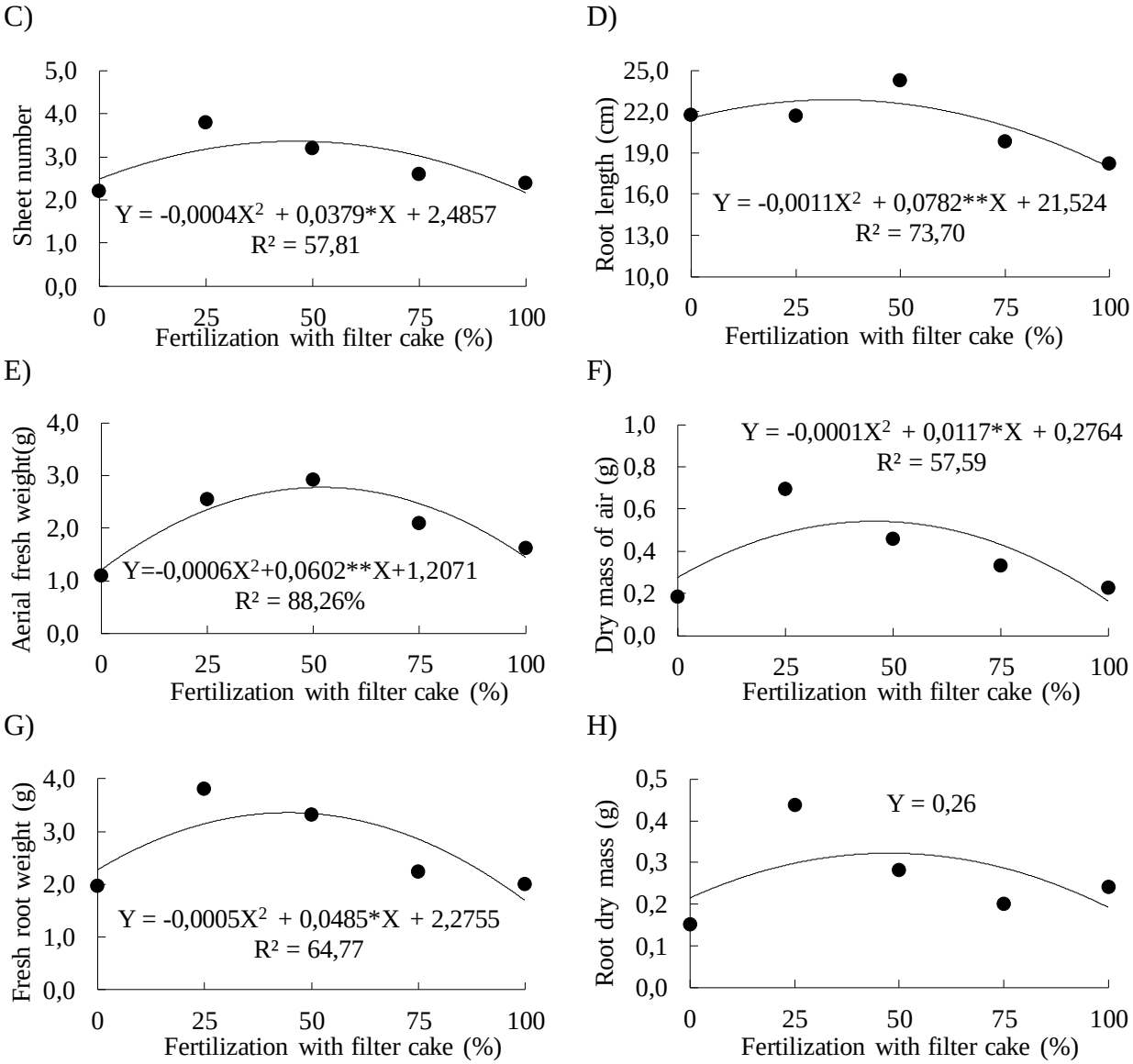
[1]Fertilization with filter cake. Source of variation (FV), Degree of freedom (DF), mean square (QM) and coefficient of variation (CV). * And ** mean 1 and 5% probability, respectively, mean not the F test at 5% probability.
Source: Prepared by the authors

In Table 1 it is important to check the level of significance, the mean square of the variables according to the result of the analysis of variance. In addition, the table shows the respective variation coefficients (CV%) for the data of the PH, SD, NL, RL, AFM, FRM, ADM e DRM.

As the regression equation, there are adjustments to quadratic model for time varying plants, stem diameter, leaf number, root length, aerial fresh weight, shoot dry weight, fresh weight of root, dry weight of the seedling root okra a result of fertilization with filter cake in proportions of 0, 25, 50, 75 and 100% (Figure 1).

Figure 1. Plant height (A), stem diameter (B), sheet number (C), root length (D), aerial fresh weight (E) Fresh root weight (F) dry mass of air (L), root dry mass (M) of okra seedlings depending on the filter cake proportions of 0, 25, 50, 75 and 100%.





Source: Prepared by the authors

In Figure 1 it is important to check the result of the regression analysis with the maximum points of the plant height, stem diameter, sheet number, root length, aerial fresh weight, fresh root weight, dry mass of air and root dry mass of okra seedlings with the respective maximum proportions of filter cake.

The increase in the amount of filter cake afforded increase in plant height to the estimated proportion of 49.58%, associated with this dose was obtained the maximum height of 3.63 cm plants, representing an increase of 24.48, 6.02, 6.43, 24.31% relative proportions of 0, 25, 75 and 100%, respectively (Figure 1A). The okra plants have increased height particularly when nitrogen requirements and phosphorus and other essential nutrients are met (Medeiros et al. 2018), in addition to suitable organic load of the filter cake can improve the activation of microbial processes, and to promote the structure, aeration and water holding

capacity, there by improving plant growth (Salles et al. 2017).

It was observed that the increase in the amount of filter cake favored increased stem diameter to the proportion of 55.83%, with a maximum estimated diameter 3.63 cm. With this filter cake proportion of the stems of okra seedlings were 25.78; 7.86; 3.04 and greater than 16.13% when used in proportions of 0, 25, 75 and 100%, respectively (Figure 1B). Nutrient deficiency symptoms such as phosphorus and nitrogen include the production of thin stems (Taiz et al., 2017), therefore, the absence of filter cake or the use of lower ratios such as 25% can restrict the growth and development stem furthermore, the excess of nutrients in higher proportions filter cake may have phytotoxic effects on plants (Farias et al., 2019).

The proportion of 47.25% filter cake was observed to increase the maximum number of sheets, averaging 3.38 per plant leaves (Figure 2C). The maximum number of sheets in okra seedlings estimated at the rate of 47.25% was 26.53, 5.92, 9.02 and 32.74% greater than the ratios of 0, 25, 75 and 100%, respectively.

One of the major nutrients found in the filter cake is phosphorus (P) (Salles et al. 2017), the P plays important roles in energy storage or the structural integrity of plant, besides being phosphate sugar component, nucleic acid , nucleotides, coenzymes, phospholipids and plays a central role in reactions involving ATP (adenosine triphosphate) (Taiz et al. 2017). Therefore, adequate concentrations of P and other nutrients promote the growth and development of okra seedlings.

The increase in the proportion of filter cake induced increase in length from the root to the proportion of 35.55%, reaching a maximum of 22.91 cm as regression equation, the increase is 6.07; 7.47 and 19.94% greater than the ratios of 0, 75 and 100%, respectively (Figure 2D). The growth patterns of the roots can be changed mainly in response to nutrient water availability (Taiz et. al 2017), the measure there was an increase in the filter cake levels root length showed a growth reduction trend, which It can be justified by the greater availability of nutrients and reduction of resource allocation to the roots.

The increase in the proportion of filter cake gave increased fresh and dry mass proportion of up to 50.17% and 58.50%, these proportions with the fresh weight was reached maximum of 2.72 g and 0.62 g dry, representing an increase of 55.57, 13.99, 13.62 and 54.84% greater than the ratios of 0, 25, 75 and 100% fresh weight, respectively (Figure 2G). The maximum increase in dry mass air okra seedlings estimated at the rate of 58.50% was 55.32; 18.14, 4.40 and 27.84% greater than the ratios of 0, 25, 75 and 100%, respectively.

The increase in the proportion of filter cake provided an increase in fresh and dry from root to the proportion of 48.50 and 45.00%, respectively. With this ratio has reached the

maximum fresh and dry weight of 3.45 g and 0.32 g, respectively, representing an increase of 34.07; 8.00, 10.17 and 38.42% relative proportions of 0, 25, 75 and 100%, respectively (Figure 2H). The dry root mass maximum of okra seedlings estimated at the rate of 45.00% was 31.99; 6.32, 14.22 and 47.79% greater than the ratios of 0, 25, 75 and 100%, respectively.

4. Conclusion

The use of waste from the sugar industry as the filter cake can be used for fertilization of okra seedlings.

It is recommended to use 55% of the proportion of filter cake and 45% soil, that the dose okra seedlings exhibit the best growth and development.

The study of the growth, development and productivity of okra with application of filter cake is recommended. In addition, studies with other agro-industrial residues may show benefits to the soil and reduced production costs for the production of vegetables, being recommended for future studies.

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