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Organic fertilization with poultry litter and sugarcane juice quality

Adubação orgânica com cama de aviário e qualidade do caldo da cana-de-açúcar

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Mauro Wagner de Oliveira
Doutor em Ciências - Energia Nuclear na Agricultura
Universidade Federal de Alagoas -
Centro de Ciências Agrárias - BR 104, Km 85 Rio Largo - Alagoas
E-mail: maurowoliveira@gmail.com

Terezinha Bezerra Albino Oliveira
Doutora em Engenheira de Produção
Universidade Federal de Alagoas -
Centro de Ciências Agrárias - BR 104, Km 85 Rio Largo - Alagoas
E-mail: tbalbino@ceca.ufal.br

Christiano Nascif
Mestre em Produção de Ruminantes
Universidade Federal de Viçosa
Rua Aimorés, 19, Bairro São Sebastião, Viçosa - Minas Gerais
E-mail: christianonascif@gmail.com

Carlos Henrique de Castro Nogueira
Mestrando em Agronomia – Produção Vegetal
Universidade Federal de Alagoas
Centro de Ciências Agrárias - BR 104, Km 85 Rio Largo - Alagoas
E-mail: henriquenogueira.contato@gmail.com

Wesley Oliveira de Assis
Engenheiro Agrônomo
Universidade Federal de Alagoas
Centro de Ciências Agrárias - BR 104, Km 85 Rio Largo - Alagoas
E-mail: wesleyoliveiradeassis@hotmail.com

Sávio Tavares Ferreira Borges
Engenheiro Agrônomo
Universidade Federal de Alagoas
Centro de Ciências Agrárias - BR 104, Km 85 Rio Largo - Alagoas
E-mail: saviotavares2008@hotmail.com

ABCTRACT
The ripening of sugarcane is influenced by weather conditions, crop variety and practice. Harvesting ripe sugarcane reduces transportation costs and increases industrial efficiency and alcoholic fermentation. The aim of this study was to evaluate the influence of organic fertilization with poultry litter on sugarcane ripening and juice quality. We used first and second regrowth of sugarcane variety RB867515 grown in medium-textured soil. The study was conducted in the city of Viçosa, state of

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Minas Gerais (MG), Brazil. The experiment was a randomized complete block design with four replicates. The treatments consisted of three doses of poultry litter (7.0; 10.0 and 13.0 t of dry matter ha/yr), chemical fertilization (180 kg N + 225 kg K ha/yr) and a control (no chemical or organic fertilization). In both years, sugarcane was harvested in early August. There was no influence of poultry litter fertilization on sugarcane ripening and juice quality. The average contents of soluble solids, sucrose in juice, stalk fiber and juice purity were respectively 22%; 19% and 88%.

Key words: Production system, sustainability, agricultural management.

RESUMO

A maturação da cana-de-açúcar é influenciada pelas condições climáticas, variedades e práticas culturais. Quando se colhe a cana madura diminuem-se as despesas com transporte e aumenta-se a eficiência industrial e da fermentação alcoólica. O objetivo deste estudo foi avaliar, na cana de primeira e segunda rebrotas, a influência da adubação orgânica com cama de aviário sobre a maturação da cana e a qualidade do caldo. O estudo foi conduzido em Viçosa-MG, utilizando a variedade de cana-de-açúcar RB867515, cultivada em solo de textura média. O delineamento experimental foi o de blocos ao acaso, com quatro repetições. Os tratamentos foram três doses de cama de aviário: 7,0; 10,0 e 13,0 t de matéria seca de cama de aviário por hectare por ano, mais dois tratamentos para comparação: 1)Testemunha: sem adubação química ou orgânica; 2) Adubação química: 180 kg de N + 225 kg de K por hectare por ano. Nos dois anos, a cana foi colhida no início de agosto. Não houve influência da adubação com cama de aviário sobre a maturação da cana e a qualidade do caldo. Os teores médios de sólidos solúveis, sacarose no caldo e pureza do caldo foram respectivamente de 22%; 19% e 88%.

Palavras-chave: Sistema de produção, sustentabilidade, gerenciamento agrícola.

1 INTRODUCTION

The ripening of sugarcane is influenced by weather conditions, crop variety and practice. Harvesting ripe sugarcane reduces transportation costs and increases industrial efficiency and alcoholic fermentation. As sugarcane produces a large amount of dry matter, it extracts and accumulates high amounts of nutrients, thus requiring the replenishment of these elements by fertilization (OLIVEIRA et al., 2018). Poultry litter is waste from poultry production that could replace chemical fertilization. However, studies should be conducted to evaluate possible changes in the ripening of sugarcane and the quality of juice caused by the use of this organic fertilizer. Thus, this study aimed to evaluate (in the first and second regrowth sugarcane) the influence of organic fertilization with poultry litter on sugarcane ripening and juice quality.

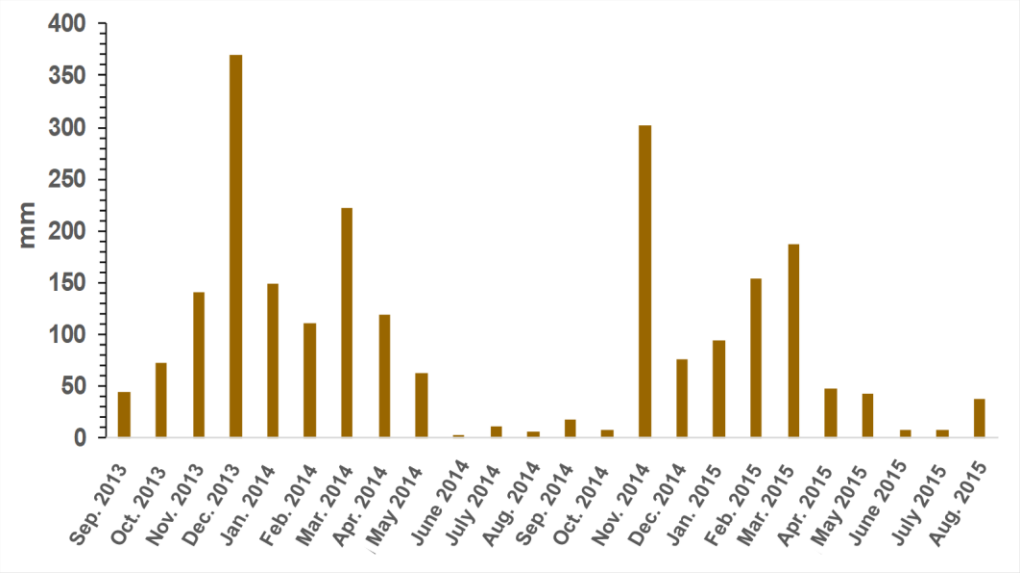
2 MATERIAL AND METHODS

The study was conducted in a medium-textured soil in the city of Viçosa, state of Minas Gerais (MG), Brazil. The climate of the region is subtropical highland (Cwb) with rainy summer and mild temperatures, according to Köppen classification. The average rainfall over the last 30 years has been approximately 1,200 mm. There is a water surplus from November to April. Rainfall is below

potential evapotranspiration from April to September, causing a water deficit during this period. And from September to November, rainfall is once again above potential evapotranspiration, during which there is a dry season and a rainy season.

Rainfall during the study period (September 2013 to August 2015) is shown in Figure 1. The dry and rainy seasons are clearly separate. In the two agricultural years, September 2013 to August 2014 and September 2014 to August 2015, rainfall was 1,310 and 944 mm, respectively.

Figure 1 - Monthly rainfall from September 2013 to August 2015.



Source: Oliveira, 2017.

Prior to the installment of the study, soil samples were collected at depths of 0-20 and 20-40 cm to assess soil fertility. Based on the results (Table 1), limestone and gypsum were applied to the soil to raise base saturation to 60% at the 0-20 cm layer and reduce aluminum saturation in the subsurface layers, as proposed by Oliveira et al. (2018). Magnesian limestone was used because of its availability in the region and also because Mg^{+2} content is above 0.40 $cmol_c\ dm^{-3}$ soil, level which is considered critical by Oliveira et al. (2018).

The sugarcane was planted in October 2012 and harvested in August 2013. In September 2013, our study was installed. The study was conducted in a randomized block design with four replicates. The treatments for both first regrowth and second regrowth sugarcane consisted of three doses of poultry litter (7.0; 10.0 and 13.0 t of dry matter ha/yr), chemical fertilization (180 kg N + 225 kg K ha/yr) and a control (no chemical or organic fertilization).

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Table 1- Chemical analysis of the soil of the study area at 0-20 and 20-40 cm, prior to the study.

Depth (cm)	pH H_20	P	K	Na	Al^{+3}	Ca^{+2}	Mg^{+2}	B	CEC (t)	CEC (T)	V	m
		--- mg dm^{-3} --			---------- $cmol_c$ dm^{-3} ----------						----- % ------	
0-20	4.9	2.0	15	0	0.30	1.2	0.50	1.74	2.04	4.24	41.01	14.72
20-40	4.4	0.8	7	0	0.50	0.4	0.20	0.62	1.12	3.42	18.08	44.73

pH in water (1:2.5 ratio). Ca^{2+}, Mg^{2+} and Al^{3+} extracted by 1 mol L^{-1} KCl. P, K and Na extracted by Mehlich-1. H^{+} + Al^{3+} extracted by 0.5 mol L^{-1} calcium acetate at pH 7.0.

In August 2014 and August 2015, when the first and second regrowth sugarcane were ripe, samples of industrializable stalks were harvested in the center of the plots to analyze juice quality. The sugarcane was cut close to the ground, clipped and stripped. Ten industrializable stalks were selected from each plot. These stalks were passed on forage choppers, and then homogenized. A subsample of 500 g was pressed at 250 kgf cm^{-2} for one min (FERNANDES, 2000). At this point, we determined soluble solids ("Brix"), apparent sucrose ("POL"), juice purity ("Purity"), apparent sucrose in stalks ("PCC"), stalk fiber (Fiber) and total recoverable sugars (TRS), following methods described by Fernandes (2000) and Oliveira et al. (2014). The mean values of soluble solids, apparent sucrose, juice purity, apparent sucrose in stalks, stalk fiber and total recoverable sugars were submitted to analysis of variance.

3 RESULTS AND DISCUSSION

Table 2 shows the analysis of variance for soluble solids, apparent sucrose, juice purity, apparent sucrose in stalks, stalk fiber and total recoverable sugars. Treatments did not affect juice quality in the first and second regrowth cycle. Thus, if we consider juice quality alone, we can assume poultry litter is an alternative fertilizer for sugarcane, even at higher doses of 13.0 t of dry matter per hectare.

The values of soluble solids, apparent sucrose, juice purity, apparent sucrose in stalks, stalk fiber and total recoverable sugars found in this study are considered exceptional based on the citations of Fernandes (2000), Oliveira et al. (2014) and Oliveira et al. (2017). We did not find any studies in the literature on fertilization of sugarcane regrowth with poultry litter in which juice quality was assessed using high doses of this waste. Thus, our results were compared to studies using chemical fertilization in production systems adopted by alcohol mills and distilleries.

In research conducted in Serra dos Aimorés (MG) with RB867515, Oliveira et al. (2014) reported concentrations of soluble solids of 21.22% and juice purity of 86.90%. In studies conducted in the Mata Alagoana region with RB867515, Oliveira et al. (2011) found mean values of Brix, POL, juice purity and TRS in the first regrowth cycle of 20.15, 16.66, 82.50 and 138.45, respectively. The mean values of Brix, POL, juice purity and TRS found in our study were higher in comparison to

those of the studies cited by Oliveira et al. (2011), Oliveira et al. (2014) and Oliveira et al. (2017). The harvest season and weather conditions most likely had an effect on the results of this study. The sugarcane harvest took place in August, following two months of extremely low rainfall (Figure 1). The location of the study in a hillside area, where there is more wind, must also have contributed to further dehydrate sugarcane and increase soluble solids and apparent sucrose contents in juice, consequently increasing the mean values of TRS.

TABLE 2. Analysis of variance for the contents of soluble solids in juice ("Brix"), apparent sucrose in juice ("POL"), juice purity ("Purity"), apparent sucrose in stalks ("PCC"), fiber in industrializable stalks (Fiber) and Total Recoverable Sugars ("TRS", in kg t^{-1} of stalks) of the RB867515 sugarcane variety, in the first and second regrowth cycles, as a function of fertilization.

---------- First regrowth cycle ----------							
Variation source	DF	---------- Means squared ----------					
		Brix	**POL**	**Purity**	**PCC**	**Fiber**	**TRS**
Fertilization	4	0.2125 ^{ns}	0.5161 ^{ns}	2.753^{ns}	0.237 ^{ns}	0.618 ^{ns}	17.5960 ^{ns}
Waste	15	0.5502	0.3708	4.7551	0.2363	0.1028	25.8885
C.V. (%)		3.34	2.70	2.47	2.94	2.23	2.81
Overall mean		22.23%	19.62%	88.30%	16.50%	14.37%	162.81 kg t^{-1}
----------	**Second regrowth cycle** ----------						
Variation source	DF	---------- Means squared ----------					
		Brix	**POL**	**Purity**	**PCC**	**Fiber**	**TRS**
Fertilization	4	0.2056 ^{ns}	0.5012 ^{ns}	2.543^{ns}	0.223 ^{ns}	0.607 ^{ns}	17.4567 ^{ns}
Waste	15	0.5405	0.3651	4.345	0.2214	0.1124	25.6721
C.V. (%)		3.52	2.84	2.63	3.01	2.45	2.98
Overall mean		22.04%	19.26%	87.39%	16.12%	14.21%	160.34 kg t^{-1}

^{NS}: not significant (P > 0.05) CV: coefficient of variation.
Source: Author

4 CONCLUSIONS

The fertilization of sugarcane with poultry litter, even at high doses, did not interfere with ripening and did not affect juice quality. Thus, poultry litter could be an alternative to chemical fertilization.

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