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GROWTH AND DEVELOPMENT OF LEAF AREA OF SUGARCANE AS AFFECTED BY SOURCES AND NITROGEN RATES

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ABSTRACT: The knowledge of leaf area is extremely important, especially for non-destructive measurements over time. the objective of this study was to evaluate the effects of N sources and rates on the growth and development of leaf area of sugarcane (CTC-4 variety), in the cane-plant cycle, cultivated in a dystroferric Red Latosol. The experiment was carried out under field conditions at Fazenda Rio Paraiso II, belonging to the Raízen Usina, in the municipality of Jataí, GO, southwest region of Goiás, Brazil. The experimental design used for the biometric growth assessments was a randomized block design, with three replicates, in a 4 × 2 × 4 subdivided scheme. The treatments were four doses of N (0, 60, 120 and 180 kg ha^{-1}), two N sources (urea and ammonium nitrate) and four evaluation periods (210, 250, 290 and 330 days after planting - DAP). The increase of the nitrogen fertilizer rate provided an increase in leaf area. At 330 DAP, the dry mass of the pointer occurred. The highest leaf area was reached at 250 DAP.

KEYWORDS: *Saccharum officinarum*, urea, ammonium nitrate, Oxisol

EVAPOTRANSPIRAÇÃO DA CULTURA EM SOJA SOB CONDIÇÃO DE CERRADO USANDO ALGORITMO SEBAL

RESUMO: O conhecimento da área foliar é extremamente importante, especialmente para medições não destrutivas ao longo do tempo. O objetivo deste estudo foi avaliar os efeitos de fontes e doses de N no crescimento e desenvolvimento da área foliar da cana-de-açúcar (variedade CTC-4), no ciclo de cana-planta, cultivada em um Latossolo Vermelho distroférrico, fase cerrado. O experimento foi conduzido em condições de campo, na Fazenda

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Rio Paraiso II, pertencente à Usina Raízen, no município de Jataí, GO, região sudoeste de Goiás, Brasil. O delineamento experimental utilizado para as avaliações biométricas de crescimento foi o de blocos casualizados, com três repetições, em esquema de parcelas subdivididas 4 × 2 × 4. Os tratamentos foram quatro doses de N (0, 60, 120 e 180 kg ha^{-1}), duas fontes de N (ureia e nitrato de amônio) e quatro épocas de avaliação (210, 250, 290 e 330 dias após o plantio - DAP). O aumento da dose de adubação nitrogenada proporcionou aumento da área foliar. Aos 330 DAP, ocorreu a maior massa seca do ponteiro. A maior área foliar foi atingida aos 250 DAP.

PALAVRAS-CHAVE: *Saccharum officinarum*, Ureia, Nitrato de amônia, Latossolo

INTRODUCTION

The favorable soil and climate conditions place Brazil as the world's major sugarcane producer, with a total production of 633.26 million tons a year, followed by India and China (FAO, 2012; CONAB, 2018). Through the production of sugar and ethanol, in addition to several other important products, the sugar and ethanol industry has occupied a prominent place in Brazilian agribusiness, the sugarcane is the main source of renewable energy in the Brazilian energetic matrix. (MONTEIRO & SENTELHAS, 2014).

Nitrogen is considered a key indicator of the physiological susceptibility of water availability and crop nutrient stress, which could potentially affect crop productivity, in addition, nitrogen is one of the primary regulators of several leaf physiological processes; insufficient nitrogen application leads to lower yields, lower sugarcane quality (FIELD et al., 1986; ABDEL-RAHMAN et al., 2010). Therefore, knowledge of leaf area is extremely important, especially for non-destructive measurements over time (OLIVEIRA et al., 2017).

The plant leaf area is used in nutrient requirements, in models to calculate the evapotranspiration, in irrigation water requirements, pruning and many different agricultural practices (COELHO FILHO et al., 2012). The objective of this study was to evaluate the effects of N sources and rates on the growth and development of leaf area of sugarcane (CTC-4 variety), in the cane-plant cycle, cultivated in a dystroferric Red Latosol.

MATERIAL AND METHODS

The experiment was carried out under field conditions, during the 2014/2015 growing season, in an area at Rio Paraiso II Farm (Raízen plant Mill, in the municipality of Jataí - GO.

The geographical coordinates of the site are 17°44'2.62 "S and 51°39'6.06" W, with an average altitude of 907 meters. According to the classification of Köppen & Geiger (1928), the climate of the place is type Aw, tropical, with rainfall from October to April, and dries from May to September. The maximum temperature ranges from 35º to 37ºC, and the minimum of 12 to 15 ºC (in the winter there are occurrences of up to 5º degrees). The annual precipitation reaches approximately 1,800 mm, but poorly distributed throughout the year.

The soil of the experimental area is classified as Dystropherric Typic Rhodic Hapludox soil and dystroferric Red Latosol, very loamy, cerrado (savanah) phase (SANTOS et al., 2013). The chemical, physical-water, granulometry and textural classification of the samples collected previous to the installation of the experiment are described in Table 1.

Table 1. Chemical, physical-water, granulometry and soil textural classification of the experimental area, 0.00-0.20 and 0.20-0.40 m depth, Jataí - GO, Brazil, 2014/15 harvest.

Layers	pH	O.M.	K	Ca	Mg	Al	H+Al	BS	CEC
(m)	$CaCl_2$	(g dm^{-3})			---------- ($mmol_c$ dm^{-3}) ----------				
0–0,20	6,6	86	1,1	37	18	<1	18	56,1	74,1
0,20-0,40	6,0	75	0,9	23	13	<1	20	36,9	56,9
Layers	V	P resin	S	B	Cu	Fe	Mn	Zn	
(m)	(%)			---------- ($mmol_c$ dm^{-3}) ----------					
0-0,20	76	16	10	0,18	1,7	68	3,4	1,4	
0,20-0,40	65	11	8	<0,2	1,3	52	2,2	1,0	
Layers	Granulometry (g kg^1)			θ_{CC}	θ_{PMP}	Textural classification			
	(m)	Sand	Silt	Clay	cm^3. cm^{-3}				
0–0,20	96	82	822	46,3	22,6	Clayey			
0,20-0,40	85	71	845	45,8	22,6	Clayey			

The experimental design was a randomized block, analyzed in a 4 x 2 factorial scheme, with three replicates. The treatments were four N rates (30, 60, 120 and 180 kg N ha^{-1}); two N sources of N fertilizer (urea and ammonium nitrate). For the biometric growth evaluations, four evaluation periods (210, 250, 290 and 330 days after planting - DAP) were evaluated, that is, a 4 × 2 × 4 factorial scheme.

Two tillers were collected in the central lines of the subplots to evaluate the variables leaf length (LL), leaf width (LW) and leaf area (LA), according to Benincasa (2003), the leaf area was determined by counting the number of green leaf (fully expanded leaf with a minimum of 20% of green area counted from leaf +1) and by measuring leaf +3, the length and width of the leaf in the median portion, according to methodology described by Hermann & Câmara (1999):

$$AF = C \times L \times 0.75 \times (N + 2) \quad (1)$$

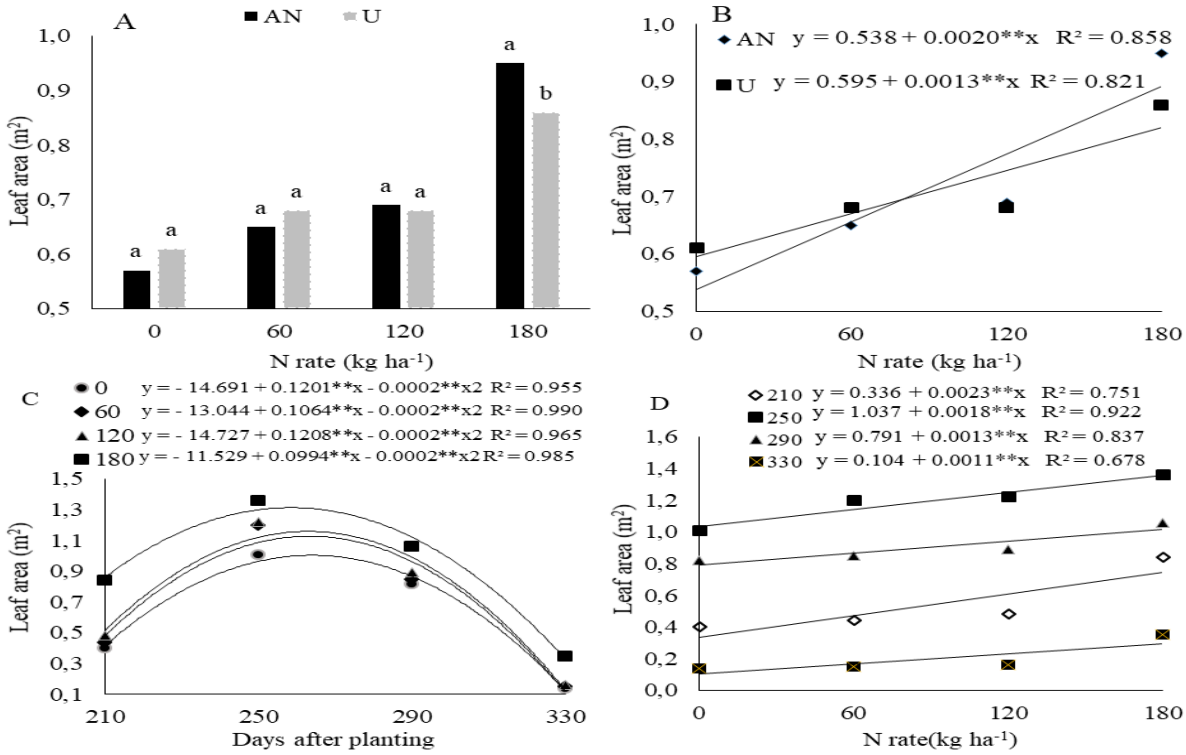
on what: *C* - sheet length +3; *L* - sheet width +3; *0.75* - correction factor for leaf area of the crop; *N* - number of open leaf with at least 20% green area.

The data obtained were analyzed statistically by variance analysis and when detected significant effects (F test 5% of probability), they were adjusted to regression equations.

Linear and quadratic components were tested and chosen the model with larger significant degree. The means for N source (urea and ammonium nitrate) were compared by the Tukey test to 5% of probability. The statistical analyses were carried out using the SAS package 8.02 (SAS, 2001).

RESULTS AND DISCUSSION

The unfolding of the FN x DN for the variable AF is shown in Figures 1A and 1B, whose averages for the doses of FN-urea were 0.61, 0.66, 0.71 and 0.85 m^2; already for the FN-nitrate were 0.58; 0.65; 0.67 and 0.93 m^2, with DN 0, 60, 120 and 180 kg ha^{-1}, respectively.



** and * significant respectively at 1% and 5% probability according to test

Figure 1. Leaf area of sugarcane as a function of N (A, B and D) and days after planting (C), Jataí-GO municipality, Brazil.

The dose of 180 kg ha^{-1} as ammonium nitrate provided the highest average of PA, compared to the other treatments, which increased by 8.60% of PA when compared to the same dose of urea (Figure 1A). The growth of FA can be influenced by the intrinsic characteristics of each variety, such as width, leaf length and leaf senescence, thus, each variety may present different behavior throughout the vegetative cycle (OLIVEIRA et al., 2007).

The lowest estimates were observed at 330 DAP, with averages of 0.11; 0.14; 0.24 and 0.27 m^2, with application of 0, 60, 120 and 180 kg ha^{-1} of N, respectively (Figure 1C). At doses of 0, 60, 120 and 180 kg ha^{-1} of N at 210 DAP, AF of 0.42; 0.48; 0.84 and 1.16 m^2, respectively, while in the period of 290 DAP presented those of 0.88, 0.94; 1.05 and 1.13 m^2, respectively (Figure 1D).

For Oliveira et al. (2007) the study of the leaf area in sugarcane allows correlating its productive potential with the growth rates of the crop. The development of leaf area is critical for the establishment of the crop and the closing of the canopy and maximization of the radiation interception in search of crop productivity (SINCLAIR et al., 2004).

For all doses of N, at 250 DAP, the highest estimated values of FA were observed, and, independent of DN, the lowest estimates of FA were observed at 330 DAP (Figure 1D). Silva et al. (2015) in study with irrigated sugarcane in a Brazilian Oxisol, found a significant effect on leaf number and leaf area for nitrogen rate and water reed in cane-plant.

CONCLUSIONS

Regardless of the source used, the increment of the dose of N provided an increase in leaf area. The largest leaf area of sugarcane was reached 250 days after planting.

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