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LEAF GROWTH AND DEVELOPMENT OF SUGARCANE IRRIGATED AND FERTILIZED WITH DIFFERENT SOURCES AND DOSES OF NITROGEN

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1 ABSTRACT

The objective of this study was to evaluate the effects of N sources and doses on the leaf growth and development of sugarcane irrigated (CTC-4 variety), in the cane-plant cycle, cultivated in a Red Oxisol of Cerrado (savannah) phase. 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. The highest leaf area was reached at 250 DAP. At 330 DAP, the dry mass of the pointer occurred. The sugarcane leaf area is greater with ammonium nitrate at a dose of 180 kg ha^{-1}.

Keywords: *Saccharum* spp., urea, ammonium nitrate, Oxisol.

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CRESCIMENTO E DESENVOLVIMENTO FOLIAR DA CANA-DE-AÇÚCAR IRRIGADA E ADUBADA COM DIFERENTES FONTES E DOSES DE NITROGÊNIO

2 RESUMO

O objetivo deste estudo foi avaliar os efeitos de fontes e doses de N no crescimento e desenvolvimento foliar da cana-de-açúcar irrigada (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 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

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proporcionou aumento da área foliar. A maior área foliar foi atingida aos 250 DAP. Aos 330 DAP, ocorreu a maior massa seca do ponteiro. A área foliar da cana-de-açúcar é maior com nitrato de amônio na dose de 180 kg ha^{-1}.

Palavras-chave: *Saccharum* spp., ureia, nitrato de amônia, Latossolo.

3 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 (CANA-DE-AÇÚCAR, 2018; MARTINS, 2021).

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. (DIAS NETO, 2000; 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; MOONEY, 1986; ZARCO-TEJADA; USTIN; WHITING, 2005; ABDEL-RAHMAN; AHMED; VAN DEN BERG, 2010; MIPHOKASAP; WANNASIRI, 2018).

Yield production depends on plant growth which is affected by light, temperature, water, and mineral nutrients (such as nitrogen which is the second most extracted nutrient by sugarcane); plant growth is depends on leaf area, leaf length and width, number of leaf and stem, stem width and plant height, consequently the leaf area plays an important role in plant growth analysis and photosynthesis (CHAUDHARY *et al.*, 2012).

The amount of photosynthetic light harvested depends directly on the leaf-area, which affects plant growth, development, and bio-productivity (productivity and production) and hence also the agro-economic return from the crop (yield), additionally, leaf biometrics are markers of nutritional status or environmental stress on the plant (MEZIANE; SHIPLEY, 1999; VILE *et al.*, 2005; CASTILLO *et al.*, 2012). Therefore, knowledge of leaf area is extremely important, especially for non-destructive measurements over time (OLIVEIRA *et al.*, 2017).

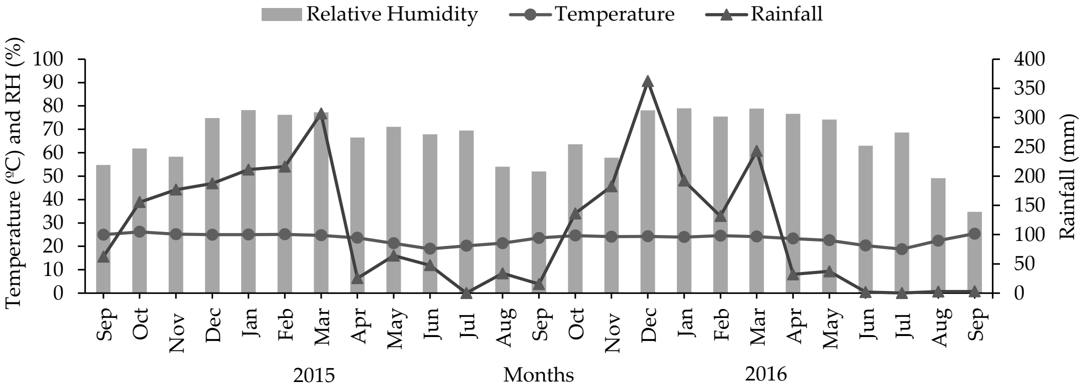
The plant leaf area is used in nutrient requirements, in models to calculate the evapotranspiration, in irrigation water requirements, pruning and many different agricultural practices (COELHO FILHO *et al.*, 2012).

The objective of this study was to evaluate the effects of N sources and doses on the leaf growth and development of sugarcane irrigated (CTC-4 variety), in the cane-plant cycle, cultivated in a Red Oxisol of Cerrado (savannah) phase.

4 MATERIAL AND METHODS

The experiment was carried out under field conditions, 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. The area is characterized, by an annual rainfall of ~1800 mm. According to the classification of Köppen and Geiger (1928), the climate of the place is type Aw, tropical, dries from May to September, and with rainfall from October to April. The average temperature is from 27ºC, and average relative humidity 66%, according to the climatic data shown in Figure 1.

Figure 1. Relative humidity, temperature and rainfall in the period resulting from the experiment, Jataí - GO, Brazil. Source: INMET Normal Station - Jataí - GO



The soil of the experimental area is classified as Red Oxisol, very loamy, cerrado (savanah) phase (SANTOS *et al.*, 2013). The experimental area has a history of sugarcane plantation of eight years of cultivation. The physical-water, chemical, textural and granulometry classification of the samples collected are described in Table 1.

Table 1. Chemical, physical-water, granulometry and soil textural classification of the experimental area (Red Oxisol), 0.00-0.20 and 0.20-0.40 m depth, Jataí - GO, Brazil.

Layers (m)	pH $CaCl_2$	O.M. gdm^{-3}	K	Ca	Mg	Al	H+Al	BS	CEC
			---------------- ($mmol_c\ dm^{-3}$) ----------------						
0.0-0.2	6.6	86	1.1	37	18	<1	18	56.1	74.1
0.2-0.4	6.0	75	0.9	23	13	<1	20	36.9	56.9
Layers (m)	V (%)	P res	S	B	Cu	Fe	Mn	Zn	
		---------------- ($mmol_c\ dm^{-3}$) ----------------							
0.0-0.2	76.0	16	10	0.18	1.7	68	3.4	1.4	
0.2-0.4	65.0	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	$cm^3\ cm^{-3}$					
0.0-0.2	96	82	822	46.3	22.6	Clay			
0.2-0.4	85	71	845	45.8	22.6	Clay			

The experimental design was a randomized block, analyzed in a 4 × 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.

The plots consisted of six lines of sugarcane, 5 m long, spaced 1.50 m apart. The plot area was represented by three lines of 3 meters linear, in the three central lines of each plot, scoring 1.0 m at each end.

The variety used was the CTC-4. Soil preparation was performed, by means of plowing, followed by opening of the planting grooves (conventional system), according to the recommendations for the CTC-4 variety, distributing seed piece with average, of 15 gems per linear meter.

Nitrogen fertilization was performed according to the treatments, at 60 days after planting (DAP), applied to the haul. All treatments were fertilized at planting with P (100 kg ha^{-1} of P_2O_5), K (80 kg ha^{-1} of K_2O), and micronutrients, according to the recommendation of Sousa and Lobato (2004).

Irrigation was performed by a central pivot, made of galvanized steel (model PC 08-64/03 + AC), with 12 support towers. Irrigation was applied at a speed of 268 m h^{-1}, applying a gross blade of 1.35 mm. The irrigation was managed using the IRRIGER® software.

The fungicides, herbicides, insecticides, and other products were used whenever necessary.

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

$$LA = L \times W \times 0.75 \times (N + 2) \qquad (1)$$

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

The pointer yield (PY) was determined by pointers present in the subplots (pointers present in 2 m of the two central lines). The cut of sugarcane was made as close as possible to the soil, the stalks then had the pointer highlighted. They were then weighed digital scale, with a capacity of 50 kg.

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 and the means were compared by the Tukey test to 5% of probability. The statistical analyses were carried out using the SAS package 8.02 (SAS, 2001).

5 RESULTS AND DISCUSSION

It is observed by variance analysis that leaf length (LL) were significantly influenced, of the interactions NS × DN × DAP. As for leaf width (LW) and leaf area (LA), there was a significant effect of N source (NS) versus DN and DN × DAP source interactions. For the variable dry mass of the pointer, there was a significant effect of the interactions NS × DN and NS × DAP (Table 2).

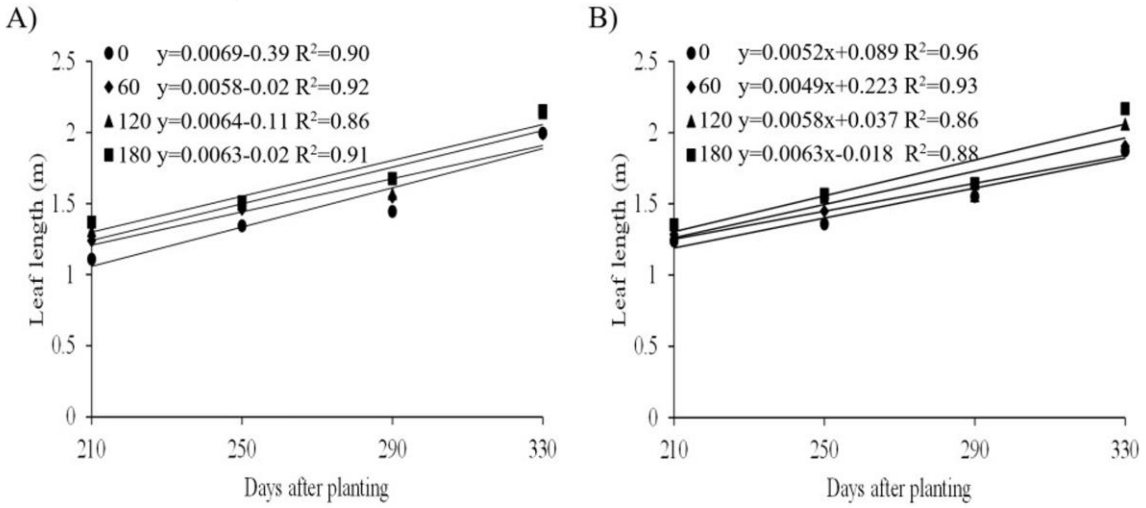
Table 2. Summary of the analysis of variance for the variables leaf length (LL), leaf width (LW), leaf area (LA) of sugarcane (cane-plant) and dry mass of the pointer (DMP) as a function of sources and nitrogen rates and epochs of evaluation, Jataí-GO, Brazil.

PV[1]		Dry mass			
	DF	LL	LW	LA	DMP
NS	1	0.0002^{ns}	0.00002^{ns}	88685.92^{ns}	2.08**
DN	3	0.164**	0.00014**	43227500.71**	11.58**
DAP	3	2.519**	0.00025**	452324568.99**	20.60**
NS × DN	3	0.003^{ns}	0.000048*	452324568.98**	0.84*
NS × DAP	3	0.013**	0.00003^{ns}	219845.04^{ns}	1.00**
DN × DAP	9	0.0065**	0.00005**	2237505.81**	0.22^{ns}
NS×DN×DAP	9	0.0055**	0.00001^{ns}	892078.68^{ns}	0.39^{ns}
Block	2	0.135	0.0006	2959564.23	1.73
Residue	62	0.002	0.00001	397146.38	0.24
CV (%)	-	2.78	6.58	8.80	12.24

[1]Nitrogen source (NS) and Doses of nitrogen (DN); Days after planting (DAP). Source of variation (PV), Degree of freedom (DF), Mean square (MS) and Coefficient of variation (CV). ** and * significant at 1 and 5% probability, respectively, ns not significant by the 5% probability F test.

The regression equation showed increases in leaf length of 14.63%, 12.26%, 12.78% and 12.25% every 40 days for N rates (ammonium nitrate) of 0, 60, 120 and 180 kg ha^{-1}, respectively (Figure 2A). Comparing leaf length, at 210 and 330 DAP, in the N rates of 0, 60, 120 and 180 kg ha^{-1}, the leaf length showed differences of 43.89%, 36.77%, 38.35% and 36.74%, respectively, in relation to the DAP. According to Lira *et al.* (2020) the total N fertilization in sugarcane were efficient for the biometric variable related to leaf length, showing differences above 30%.

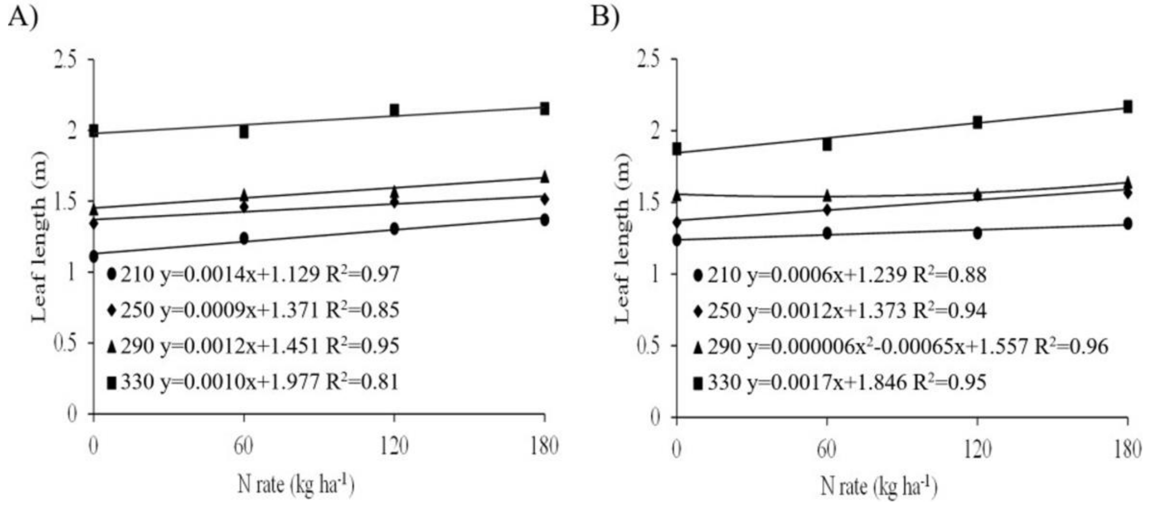
Figure 2. The leaf length of sugarcane as a function of days after planting, in the nitrogen rates of 0, 60, 120 and 180 kg ha^{-1} and for N sources of ammonium nitrate (A) urea (B), Jataí-GO, Brazil.



The regression equation showed increases in leaf length of 11.52%, 10.65%, 11.89% and 12.23% every 40 days for N rates (urea) of 0, 60, 120 and 180 kg ha^{-1}, respectively (Figure 2B). Comparing leaf length, at 210 and 330 DAP, in the N rates of 0, 60, 120 and 180 kg ha^{-1}, the leaf length showed differences of 34.55%, 31.96%, 35.66% and 36.69%, respectively, in relation to the DAP. According to Silva *et al.* (2014) the average leaf length of sugarcane fertigated with nitrogen was characterized by high growth up to 180 DAP, followed by a gradual increase until the final evaluation period, facing 181.44 cm at 330 DAP.

The regression equation showed increases in leaf length of 6.08%, 3.52%, 4.32% and 2.78% every 60 kg ha^{-1} of N (ammonium nitrate) at 210, 250, 290 and 330 days, respectively (Figure 3A). Comparing leaf length, in the N rates of 0 and 180 kg ha^{-1}, at 210, 250, 290 and 330 days, the leaf length showed differences of 18.24%, 10.57%, 12.95% and 8.34%, respectively, in relation to the N rates. According to Shigaki *et al.* (2016) the leaf length and leaf area of sugarcane fertilized with nitrogen were incremented in the three varieties in relationship to dap, with RB 863129 having the highest increases of 21 and 22%, respectively.

Figure 3. The leaf length of sugarcane as a function nitrogen rates at 210, 250, 290 and 330 days after planting for N sources of ammonium nitrate (A) urea (B), Jataí-GO, Brazil.



The regression equation showed increases in leaf length of 2.67%, 4.53% and 4.74% every 60 kg ha^{-1} of N (urea) at 210, 250 and 330 days, respectively (Figure 3B). Comparing leaf length, in the N rates of 0 and 180 kg ha^{-1}, at 210, 250 and 330 days, the leaf length showed differences of 18.24%, 10.57% and 8.34%, respectively, in relation to the N rates. Silva *et al.* (2015) in study with irrigated sugarcane in a Brazilian Oxisol, found a significant effect on leaf number, leaf length and leaf area for nitrogen rate and water reed in cane-plant.

The leaf length of the sugarcane with N fertilization at 290 DAP increased up to N rate (urea) of 180 kg ha^{-1} when they reached the maximum leaf length, approximately 1.64 m, which was 4.97%, 6.00% and 4.35%, higher than those found in the N rates of 0, 60 and 120 kg ha^{-1}, respectively (Figure 3B). The maximum leaf length contributes to a greater expansion of the leaf area, which is very important because 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; CUNHA *et al.*, 2020).

Sugarcane without fertilized of N, at 210 and 290 DAP and fertilized with 60 and 120 kg ha^{-1} of N at 330 DAP using urea source presented leaf length of 10.36%, 6.97%, 4.27% and 3.74% higher than the leaf length found in sugarcane plants with ammonium nitrate fertilization, respectively (Table 3).

Table 3. The leaf length (LL) of sugarcane fertilized ammonium nitrate (AN) and urea (U) in the N rates of 0, 60, 120 and 180 kg ha^{-1} at 210, 250, 290 and 330 days after planting, Jataí-GO, Brazil

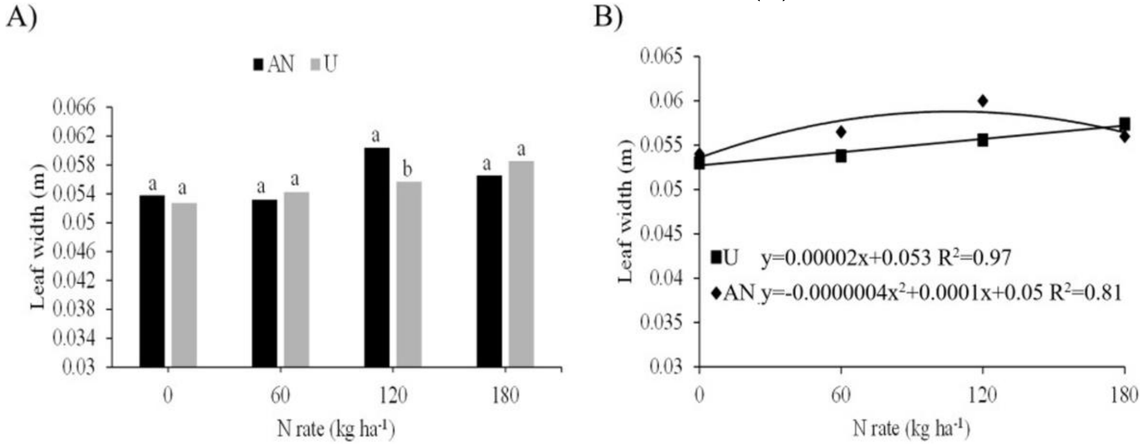
N rate (kg ha^{-1})	**DAP**	**LL (m)**	
		AN	**U**
0	210	1.11b	1.24b
	250	1.34b	1.36b
	290	1.45b	1.55b
	330	2.00a	1.87a
60	210	1.24b	1.29a
	250	1.46b	1.45a
	290	1.55b	1.55a
	330	1.99a	1.91a
120	210	1.31b	1.29a
	250	1.50b	1.55a
	290	1.57b	1.56a
	330	2.14a	2.06a
180	210	1.37a	1.35a
	250	1.51a	1.57a
	290	1.68a	1.64a
	330	2.15a	2.17a

[1]Means followed by different letters, lowercase in the row, differ by Tukey test ($p < 0.05$).

Sugarcane without fertilized of N using ammonium nitrate source at 330 DAP presented leaf length of 6.18% higher than the leaf length found in sugarcane plants with urea fertilization (Table 3). Leaf length, leaf number and leaf area are measures that allow evaluating crop yield, as they estimate the photosynthetically active surface (SILVA *et al.*, 2014). No difference in leaf length was found relative to the sources ammonium nitrate and urea in the N rates of 0 kg ha^{-1} at 250 days, of 60 kg ha^{-1} and 120 kg ha^{-1} at 210, 250 and 290 days and of 180 kg ha^{-1} at 210, 250, 290 and 330 days (Table 3).

Sugarcane fertilized with 120 kg ha^{-1} of N using ammonium nitrate source presented leaf width of 7.75% higher than the leaf width found in sugarcane plants with urea fertilization (Table 3). No difference in leaf width was found in the N rates of 0, 60 and 180 kg ha^{-1} (Figure 4A). Leaf width was broad in varieties, B 60 267 and C 86 56 (>6.00 cm) (AKHTAR; ELAHI; ASHRAF, 2001; KHAN; IQBAL; SULTAN, 2007; SILVA *et al.*, 2017).

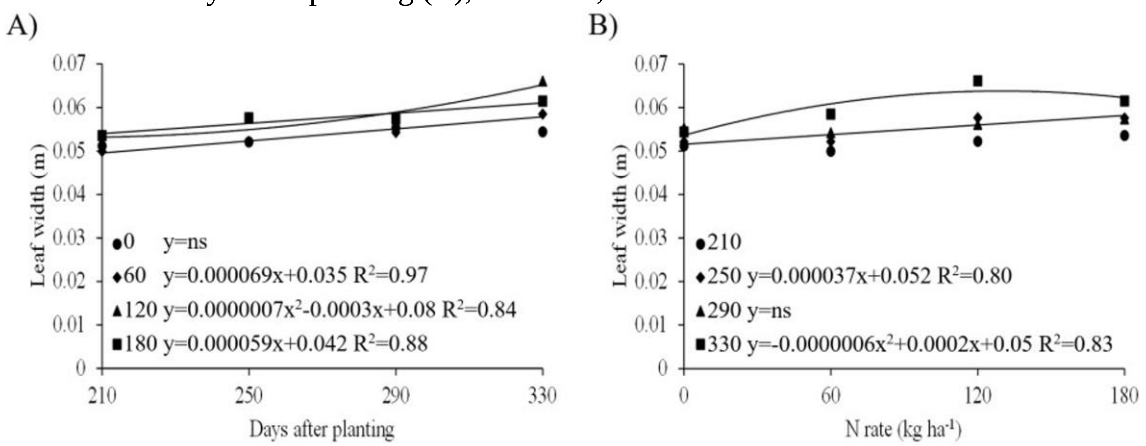
Figure 4. The leaf width of sugarcane as a function nitrogen rates in relation the N sources (A) and for N sources of ammonium nitrate and urea (B), Jataí-GO, Brazil.



Comparing leaf width, in the N rates of 0 and 180 kg ha^{-1}, the leaf width showed difference of 5.10%, in relation to the N rates (Figure 4B). The leaf width of the sugarcane with N fertilization (ammonium nitrate) increased up to N rate of 108 kg ha^{-1} when they reached the maximum leaf width, approximately 0.059 m, which was 8.88%, 1.74% and 4.02%, higher than those found in the N rates of 0, 60 and 180 kg ha^{-1}, respectively (Figure 4B). Application of the recommended dose of NPK registered the leaf width of 6.1 cm and minimum was found in the treatment with the lowest dose of N (MARY; ANITHA, 2019).

The regression equation showed increases in leaf width of 4.79% e 3.85% every 40 days in the N rate of 60 and 180 kg ha^{-1}, independently of the source used (Figure 5A). Comparing leaf width, in the N rates of 0 and 180 kg ha^{-1}, the leaf width showed difference of 14.38% e 11.56%, in relation to the N rates, respectively.

Figure 5. The leaf width of sugarcane as a function of days after planting for the N rates of 0, 60, 120 and 180 kg ha^{-1} (A) and as a function nitrogen rates at 210, 250, 290 and 330 days after planting (B), Jataí-GO, Brazil.



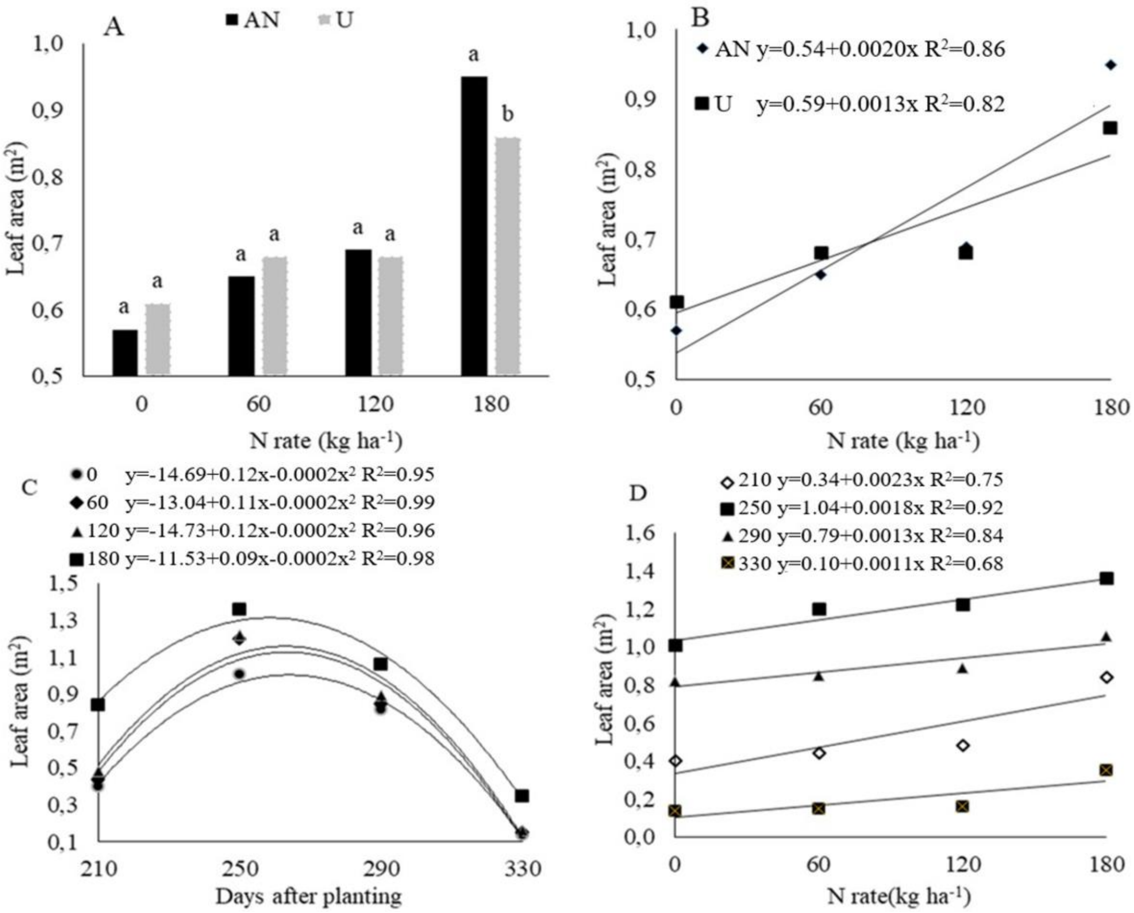
The leaf width of the sugarcane with N rate fertilization of 120 kg ha^{-1} increased up to 330 days when they reached the maximum leaf width, approximately 0.065 m, which was 18.45%, 15.79% and 9.64%, higher than those found in the DAP of 210, 250 and 290 days, respectively (Figure 5A). The regression equation showed increases in leaf width of 3.81% every 60 kg ha^{-1} of N at 250 days (Figure 5B). Comparing leaf width, in the N rates of 0 and 180 kg ha^{-1}, at 250 days, the leaf width showed difference of 11.43%, in relation to the N rates. According to Souza *et al.* (2020) of all the attributes analyzed, only leaf width and proportional leaf width showed significant differences, both with higher mean values in the treatment with N.

The leaf width of the sugarcane with N fertilization at 330 DAP increased up to N rate (urea) of 131 kg ha^{-1} when they reached the maximum leaf width, approximately 0.064 m, which was 16.05%, 4.70% and 2.28%, higher than those found in the N rates of 0, 60 and 180 kg ha^{-1}, respectively (Figure 5B).

The larger leaf width of sugarcane fertilized with N can be explained by the greater enrichment of the soil, increasing its nutritional power provided by the application of this nutrient, enabling an increase in the growth and development of the crop, consequently increasing its production capacity of biomass (BETTIOL; TRATCH; GALVÃO, 1998; RICKLEFS, 2009; CUNHA *et al.*, 2020).

The unfolding of the FN x DN for the variable LA is shown in Figures 6A and 6B, 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. Besides leaf blade length and width, the differences in leaf area were reported to be influenced by leaf surface in sugarcane varieties (SINCLAIR *et al.*, 2004; SILVA *et al.*, 2017).

Figure 6. Leaf area of sugarcane as a function of N (A, B and D) and days after planting (C), Jataí-GO, Brazil.



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

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 6A). 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; SILVA *et al.*, 2015).

The DN x DAP splitting is shown in Figure 3C and 3D. It is observed that at 250 DAP the highest LA was reached, with the dose of 180 kg ha^{-1} of N, with an estimated average of 1.32 m^2, while for the same period the averages were 0.97; 1.07 and 1.09, for the doses of 0, 60 and 120 kg ha^{-1}, respectively. 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 6C). Results found by Silva *et al.* (2014) show a higher increase in FA between 240 and 300 DAP, and there was also an exponential growth as a function of the DAP for irrigated sugarcane.

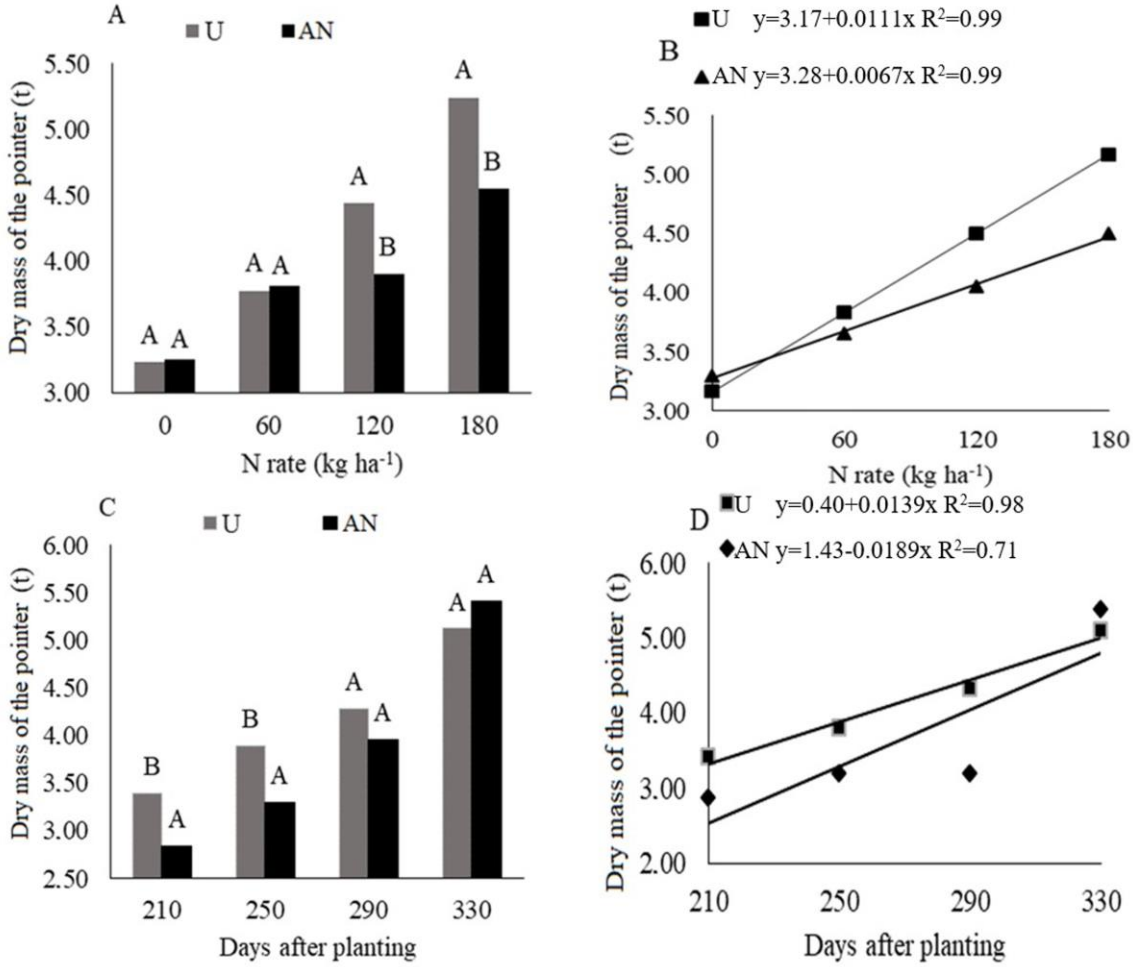
At doses of 0, 60, 120 and 180 kg ha^{-1} of N at 210 DAP, LA of 0.42; 0.48; 0.84 and 1.16 m^2, respectively, while in the period of 290 DAP presented those of 0.88, 0.94; 1.05 and 1.13 m^2, respectively (Figure 6D).

Studies have shown that the leaf area of sugarcane increases during the period of intense crop growth (Teixeira *et al.*, 2012). The study of the leaf area in sugarcane allows correlating its productive potential with the growth rates of the crop (OLIVEIRA *et al.*, 2007; CUNHA *et al.*, 2016).

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 6D). The ability to maintain LA for a long period of time, composes an important indicator of materials plus productivity, this means that the photosynthetic apparatus performs better (HERMANN; CAMAMARA, 1999; CUNHA *et al.*, 2020).

For dry mass of the pointer (DMP), the unfolding FN x DN is shown in Figure 4A and 4B, whose averages for the N doses in the urea form were 48.75; 57.11; 66.55 and 78.62 g and for the nitrate 48.48; 56.64; 58.50 and 68.26 g, with DN of 0, 60, 120 and 180 kg ha^{-1} respectively, in which the DN of 120 and 180 kg ha^{-1} of urea were statistically superior when compared to the nitrate doses (Figure 7A).

Figure 7. Dry mass of the sugarcane pointer (CTC-4) (cane-plant), (A and B) interaction sources × doses (C and D) source interaction × days after planting, Jataí-GO, Brazil.



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

The sugarcane that did not receive the nitrogen fertilizer, showed in a higher energy expenditure for the root growth, which created competition for photoassimilates for shoot growth (OTTO *et al.*, 2009; MOLIJN *et al.*, 2018), and may also explain the lower values for DMP in treatments without application of N-fertilizer.

The dose of 180 kg ha^{-1} of urea had a higher average of DMP compared to the other treatments, which means an increase of 13.17% of DMP when compared to the same nitrate dose (Figure 7A). The highest increase in DMP occurred with the application of 180 kg ha^{-1}, regardless of the applied source, whose urea at the dose of 120 kg ha^{-1} provided an estimated DMP of 66.61 g, corresponding to 15.24% lower, when compared to the dose of 180 kg ha^{-1} of urea. The application of 180 kg ha^{-1} of N in the form of ammonium nitrate provided an increase in DMP of 9.94% when compared to the dose of 120 kg ha^{-1} of N from this same source (Figure 7B).

According to Silva *et al.* (2017), there was an association between dry matter production (DMP) and length sheet (LS) to cultivate RB867515; to cultivate RB92579, there was association between number of plants (NP), number of green leaves (GL) and LAI; while to cultivate VAT90212, there was no relation in the number of leaves per plant, leaf width and leaf area per tiller.

The FN x DAP unfolding is in Figure 4C and 4D, whose mean test showed a variation at 210 and 250 DAP, of which the urea source had the highest values, 50.82 and 58.36, respectively; while for the treatment with ammonium nitrate the estimated values were 42.55 and 49.52, respectively, for the same periods (Figure 7C). The lowest values were observed at 210 DAP, with estimated averages of 43.03 and 51.23 g, with ammonium nitrate and urea sources, respectively. With application of ammonium nitrate, at 250, 290 and 330 DAP presented the estimated values of 48.11; 60.69; and 80.78 g, respectively, with the urea FN for the periods 250, 290 and 330 DAP presented the estimated values of 57.11; 65.51 and 76.43, respectively (Figure 7D). The highest increase in DMP was observed from 290 DAP to 330 DAP, for FN urea, where this increase was 14.28%, with FN ammonium nitrate, whose percentage was 24.87% (Figure 7D).

6 CONCLUSION

Sugarcane fertilized with 120 kg ha^{-1} of N using ammonium nitrate source presented leaf width of 7.75% higher than the leaf width found in sugarcane plants with urea fertilization.

The leaf width of the sugarcane with N fertilization at 330 DAP increased up to N rate (urea) of 131 kg ha^{-1} when they reached the maximum leaf width, approximately 0.064 m, that was up to16.00% higher than those found in the N rates of 0, 60 and 180 kg ha^{-1}.

For dry mass of the pointer, the averages for the N doses of 120 and 180 kg ha^{-1} of urea were statistically superior when compared to the nitrate doses.

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. The leaf area was greater with ammonium nitrate at a dose of 180 kg ha^{-1}.

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