Australian Journal of Crop Science

AJCS

AJCS 15(08):1110-1118 (2021)
ISSN:1835-2707
doi: 10.21475/ajcs.21.15.08.p2978

Responses of different varieties of sugarcane to irrigation levels in the Cerrado

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Abstract

The Cerrado is under full expansion of sugarcane cultivation. However, the climate of this biome limits the production of sugarcane due to a marked water deficit. Therefore, the objective of this study is to evaluate different varieties of sugarcane in two cultivation cycles in response to irrigation levels in the Cerrado. The experiment was conducted in Goiânia-GO, Brazil, from March 2016 to March 2018, during the cycles of plant-cane and ratoon cane in pots. The experiment was completely randomized in a 5 x 6 factorial design. The treatments were five varieties of sugarcane (RB867515, CTC11, SP860042, IAC873396, and IAC911099) and six levels of supplementary irrigation (100, 80, 60, 40, 20 and 0% of the ETc determined by weighing lysimeter), and four replications. Eight biometric analyses were performed 45 days apart. At the end of each cycle, the quality of the raw material was determined through technological analysis. At the initial development phase (between March and August), when growth is low, we found that it is better to use an irrigation level that provides at least 40% of ETc, since the Cerrado environment does not increase sugarcane height. At the growth phase (between September and March), there is active growth corresponding to 74% of the cane's height. Therefore, the ideal irrigation is that at least 80% of the ETc be provided at the growth stage to support the sugarcane to reach a maximum growth and consequently favorable technological indexes. The supplementary irrigation level of 60% of ETc accelearted the process of maturation of sugarcane for a 12-month cycle. We conclude that the level of supplementary irrigation using greater technical viability for the cultivation of sugarcane in the Cerrado is 60% of the ETc. The varieties most adapted to this production environment are RB867515 and IAC873396.

Keywords: Water deficit; Morphological analysis; Brix.

Abbreviation: ETc_culture evapotranspiration, SIL_supplementary irrigation level, DAP_days after plating, DAC_days after cutting, MSD_mean stem diameter, MHS_mean height of the stem, LA_leaf area, NGL_number of green leaves, FC_ fiber. content.

Introduction

Sugarcane is a crop of great importance to the world. About 75% of the world production of edible sugar (sucrose) comes from it (CRB, 2015). The average Brazilian productivity of sugarcane in the 2018/19 harvest was 72.2 Mg ha^{-1}. The state of Goiás/Brazil ranks second in national production, which produced 76.3 Mg ha^{-1} (CONAB, 2019).

Sugarcane finds its best growing conditions when there is a hot and humid climate, with high solar radiation during the vegetative growth phase, followed by a dry, sunny, and colder period during the maturation and harvest phases (Machado et al., 2009; Silva et al., 2012; Abreu et al., 2013). Sugarcane development conditions corroborate the prevailing climate in the Cerrado (Cardoso et al., 2014). However, the problem in achieving a high productivity in the Cerrado is linked to the occurrence of water deficit during the vegetative period, coupled with the lack of varieties adapted to such conditions. As semi-perennial crop, the sugarcane may encounter biotic stress and, particularly, abiotic during its growing period. Therefore, it is important to do morphological analysis of plants in different crop cycles (years) to research the effects of water stress in crop, since studies show different response of sugarcane varieties to different soil water availability (Inman-Bamber and Smith, 2005; Smit and Singels, 2006).

Sugarcane quality is very importance to industry, and production environment has direct influence on the raw material. On the other hand, there are quality recommended levels for sugarcane. Ripoli and Ripoli (2004), indicated that the sugarcane juice purity must be more than 85%, the HR of 11 to 13% and reducing sugars must be less than 0.80%. Soluble solids content (°Brix) should be at least 13% at harvest, but the optimum level of content is higher than 18% (Orplana, 2013).

In an evaluation of 16 varieties of sugarcane under supplementary irrigation in the Cerrado, there was a technical viability of this practice since the average stalk productivity was 147 Mg ha^{-1} (Campos et al., 2014). Silva et al. (2014) analyzed the response of different varieties of sugarcane under full irrigation in the region of Jaú, SP, and identified that the varieties IAC911099, IACSP96-3060, RB855536, RB867515, and SP851115 had a better agro-industrial productive potential and less relative water consumption. They behaved differently to full irrigation. Thus, this study was carried out to analyze the biometric and technological responses of different varieties of sugarcane in two cultivation cycles under levels of supplementary irrigation in the Cerrado.

Results

Biometric development of sugarcane

The results of analysis of variance indicated a significant difference for interactions between a number of factors such as cycle, days after planting/cutting and supplementary irrigation level (SIL). The significance was also observed between cycle, variety, and level of supplementary irrigation for all variables, except for the number of apparent green leaves (Table 1).

The MSD showed an exponential behavior with a tendency to maximum growth, whereas the MSD expansion was occurred until 135 days after planting (1st year) and cutting (2nd year). After that, the MSD showed a constant value (Figure 1). In the first year, sugarcane obtained an average MSD of 22.2 mm, while the second year averaged 17.5 mm, corroborating with Silva et al. (2012), who, found an expansion of the stem up to 132 DAC in irrigated sugarcane (RB 92579 variety), after which the MSD remained constant and close to 27 mm.

Figure 1, shows that in the first year, application of 100% supplementary irrigation level (SIL) resulted to Mean Stem Diameter (MSD) of 35.0, which was 16.5 and 8.4% higher than SIL of 0%, 20% and 40%, respectively. However, in second year, 80% SIL resulted in the highest MSD, with 22.9; 11.9 and 9.4% higher than the SIL of 0%, 20% and 40%, respectively.

Figure 2 shows a polynomial behavior of MSD in function of SIL in the first year. However, in the second year, all varieties had a adjust linear MSD in function of SIL, except for CTC11 variety, with polynomial behavior.

RB867515 variety showed the highest MSD value in first and second year, with 26.3 and 21.7 mm, respectively. The lowest MSD values were found in CTC11 variety (22.2 mm) in first year, and IAC911099 variety (16.9 mm) in second year. Similar results were reported by Silva (2007) and Oliveira et al. (2010). They evaluated the stem diameter of different varieties and found that RB867515 has the largest diameter (27 mm).

Mean height of the stem (MHS) showed an exponential behavior, with slow initial growth, followed by period of high growth, with 260 and 211 cm in first and second year, respectively (Figure 3).

MHS showed no significant difference to SIL of 80 and 100% in the first and second year. In the first year, MHS of 100% SIL was 12.9 and 41.9% higher than 60% and 0% SIL, and in second year 6.7 and 32.7% higher, respectively.

There were two distinct phases of sugarcane growth, the first between March and August (0 to 180 days). There was an average increase in plant height of 27.6 and 24.3% for the first and second year of evaluation, respectively. This period offers a short photoperiod, low solar radiation and low temperature, which caused a small plant growth even for an irrigation condition of 100% of ETc. However, in second period between September and March, which also corresponded to 180 days, there was an average increase of 72.4 and 75.7% in plant height, for the first and second year of evaluation, respectively. In this second period, the increase in photoperiod, and higher solar radiation and temperature associated with water availability, resulting from irrigation or rain, led to a greater plant growth.

MHS showed linear elongation at different SIL for all varieties, except CTC11 and IAC911099, in the first year of evaluation, with no significant difference between SIL of 80 and 100%. In the second year, MHS showed polynomial adjust, except for RB867515 and IAC911099 with linear growth (Figure 4).

RB867515, IAC873396 and IAC911099 varieties presented the highest values of MHS at 365 days, with 308, 293 and 240 cm in first year; and 246, 232 and 196 cm in second year, respectively. The varieties CTC11 and SP860042, showed the lowest values of MHS, 225 and 238 cm in first year and 194 and 187 cm in second year, respectively.

Campos et al. (2014) showed that CTC11, IAC873396, RB867515 and SP860042 varieties presented the highest MHS values among 16 varieties evaluated in Cerrado under supplementary irrigation (50% of ETc). They also reported the IAC911099 variety showed the highest stalk production.

IAC873396 variety showed a reduction in MHS between the SIL of 80 and 100% of 13.3 and 15.4%, in first and second year, respectively. However, there was a technical problem in irrigation system, at 110 days after planting, which mainly affected treatment 100% SIL. Thus, some inference about the event would be mistaken.

The development of number of green leaves (NGL) showed a polynomial adjust for SIL, quadratic for SIL above 60% of ETc, and cubic for SIL below 40%, in both years (Figure 5).

In first 30 days of experiment, irrigation was the same for all treatments, to stimulate initial growth of sugarcane plants, and after those treatments they were irrigated with different levels. Therefore, at 45 days, all SIL showed same NGL and after that there were differentiation in grown plants.

In both years, a small NGL (4.6) was observed in dry season in SIL less than 40% at 180 days, NGL (8.5) in rain season, and finally close harvest NGL (8.2) to 360 days with interruption of irrigation and leaf senescence.

SIL above 60% of ETc, caused increase of NGL until 180 DAP and 225 DAC, and then stabilization and, finally, leaf senescence in physiological maturation subperiod.

Inman-Bamber and Smith (2005), reported that sugarcane in water stress condition maintain leaves dormant at the tip, as can be seen in treatments with irrigation below 40% of ETc. In addition, the authors showed that the same sugarcane plants get rapid leaf growth after irrigation, whereas they have as many leaves as fully irrigated plants in seven days. In this work, we noticed that the rainy season causes a leaf expansion in plants that have already received less irrigation.

The LA (Figure 6) showed a quadratic polynomial behavior for SIL above 60% and a cubic polynomial adjust for SIL below 40% ETc in both years of evaluation. In second year, the leaf area was, on average, 25% smaller than in first year.

In the first year, the 100% SIL provided the largest LA, throughout the experiment, exceeding 6.0 m² after 270 days of planting. In the second year, however, the SIL of 100 and 80% showed no significant difference for this variable, with an average value of 3.3 m². In addition, at the end of the second year, all treatments had an average LA value of about 4.0 m².

During the two years, we observed that the SIL of 20 and 0% of the ETc until 200 days of conducting the experiment. The LA also remained practically constant, close to 1.35 m². From then, there was a rapid leaf growth, reaching a value close to 4.0 m², which could be observed in all treatments.

In conditions of water stress the sugarcane presents an early leaf senescence with decreased solar radiation interception and drop in transpiration and photosynthesis (Pincelli and Silva, 2012). Thus, senescence and the stop in leaf growth are the physiological response of sugarcane to water deficiency (Smit and Singles, 2006).

Sugarcane studies suggest that the reduction in NGL is related to water deficiency, which is a mechanism of plant adaptation, because it reduces transpiration surface and, the

Table 1. Biometric analysis of sugarcane in function of variety (V), supplementary irrigation level (I), and days after planting/cutting (DAP/C) in the two years (cycles) of evaluation, given the average values and the summary of statistical analysis, represented by the calculated F value, for the variables mean stem diameter (MSD), mean stem height (MSH), number of green leaves (NGL), and leaf area (LA).

Variable	MSD (mm)		MSH (cm)		NGL		LA (m^2)	
Variety (V)	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
CTC11	22.2	17.5	101.2	89.4	6.9	6.4	3.66	2.68
IAC873396	25.1	19.8	125.7	104.6	7.0	6.3	3.80	2.92
IAC911099	23.6	16.9	91.1	84.2	7.3	6.2	3.90	2.71
RB867515	26.3	21.7	130.5	111.2	6.6	5.9	3.47	2.84
SP860042	24.2	19.1	104.1	84.4	7.3	6.4	3.82	2.79
Irrigation (I)								
0%	18.3	15.2	72.7	66.9	5.2	5.0	2.32	1.91
20%	22.7	17.7	92.4	85.3	6.2	5.7	3.02	2.56
40%	24.6	18.8	106.9	91.3	6.7	6.0	3.52	2.72
60%	26.1	20.6	118.4	101.2	7.2	6.5	3.97	2.98
80%	26.8	21.0	136.1	111.8	7.9	6.9	4.56	3.22
100%	27.1	20.8	136.6	112.1	8.8	7.5	4.99	3.33
Mean	24.3	19.0	110.5	94.8	7.0	6.2	3.73	2.79
CV (%)	13.02		15.13		20.62		27.70	
Interaction								
Cycle*DAP/C	22.778*		88.444*		66.843*		44.124*	
Cycle*V	8.629*		14.889*		2.365^{ns}		5.181*	
Cycle*I	12.524*		21.460*		6.438*		23.925*	
DAP/C*V	3.164*		30.933*		4.169*		3.376*	
DAP/C*I	7.289*		29.735*		12.393*		15.014*	
V*I	3.974*		6.129*		4.615*		4.157*	
Cycle*DAP/C*V	0.540^{ns}		1.790*		1.652*		1.871*	
Cycle*V*I	3.594*		2.580*		0.834^{ns}		1.667*	
Cycle*DAP/C*I	2.809*		2.388*		7.417*		3.192*	
DAP/C*V*I	0.632^{ns}		1.172^{ns}		1.244*		1.165^{ns}	
Cycle*DAP/C*V*I	0.287^{ns}		0.457^{ns}		1.091^{ns}		0.929^{ns}	

^{ns}: not significant; *: significant at 5% error probability; CV: coefficient of variation.

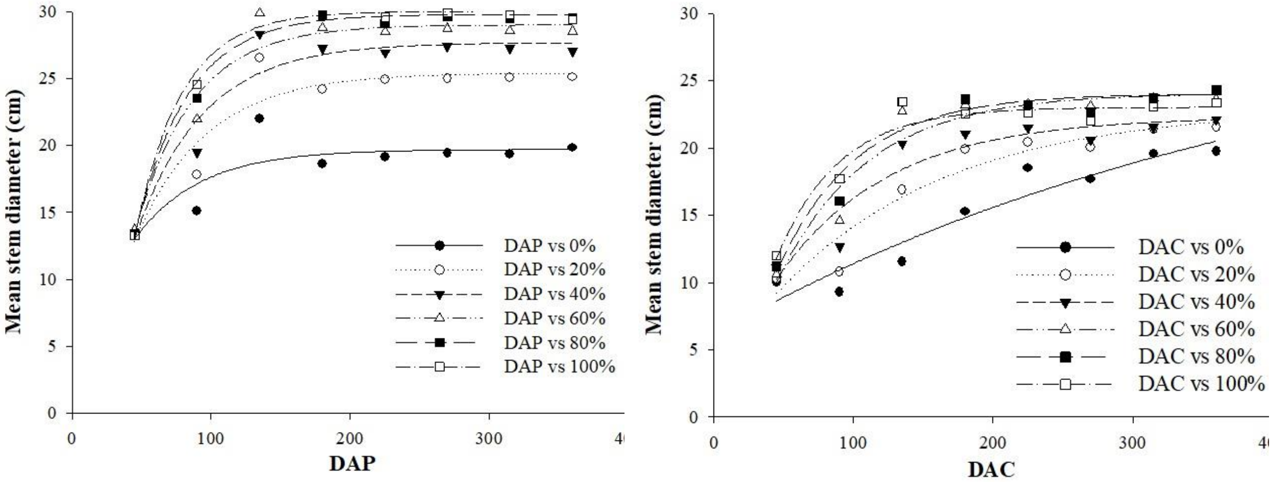

Figure 1. Mean stem diameter (mm) in function of days after planting (DAP - 1st year) and days after cutting (DAC - 2nd year) for supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of the ETc.

Table 2. Technological variables of sugarcane in function of variety and supplementary irrigation level in the first two years of evaluation. Mean values and summary of the statistical analysis, represented by mean square value for the variables, pol (%), purity (%), fibers (%), total reducing sugars (TRS, %), and brix degree (°Brix, %)

Variable	Pol (%)		Purity (%)		Fibers (%)		TRS (%)		°Brix (%)	
Variety (V)	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year	1st year	2nd year
CTC11	11.72	13.09	86.58	86.83	13.61	14.61	0.55	0.54	16.43	18.62
IAC873396	11.99	13.08	88.62	88.36	14.95	14.97	0.48	0.49	16.80	18.41
IAC911099	10.98	13.02	84.77	87.25	13.75	14.51	0.60	0.53	15.71	18.41
RB867515	12.06	13.55	86.35	87.89	13.65	14.50	0.56	0.51	16.94	19.00
SP860042	11.73	12.57	87.32	87.46	15.14	15.83	0.52	0.51	16.70	18.15
Irrigation (I)										
0%	9.22	12.80	83.22	85.95	14.12	14.87	0.64	0.56	13.55	18.48
20%	10.42	12.41	85.30	85.25	14.23	14.74	0.58	0.58	14.99	18.03
40%	11.69	12.90	88.10	87.02	13.94	14.78	0.51	0.53	16.20	18.37
60%	12.47	13.22	87.07	88.61	14.51	14.88	0.53	0.48	17.67	18.53
80%	13.15	13.44	87.78	88.91	14.21	15.07	0.51	0.47	18.38	18.84
100%	13.24	13.59	88.88	89.61	14.30	14.97	0.48	0.46	18.30	18.86
Mean	11.70	13.06	86.73	87.56	14.22	14.88	0.54	0.51	16.51	18.52
CV (%)	11.94		3.32		6.99		15.72		10.03	
Interaction										
Cycle*V	2.45^{ns}		15.76^{ns}		1.89^{ns}		0.01^{ns}		2.92^{ns}	
Cycle*I	15.75*		17.20^{ns}		0.37^{ns}		0.01^{ns}		30.93*	
V*I	0.63^{ns}		6.00^{ns}		0.58^{ns}		0.01^{ns}		0.68^{ns}	
Cycle*V*I	0.46^{ns}		4.40^{ns}		0.52^{ns}		0.01^{ns}		0.58^{ns}	

^{ns}: not significant; *: significant at 5% error probability; CV: coefficient of variation.

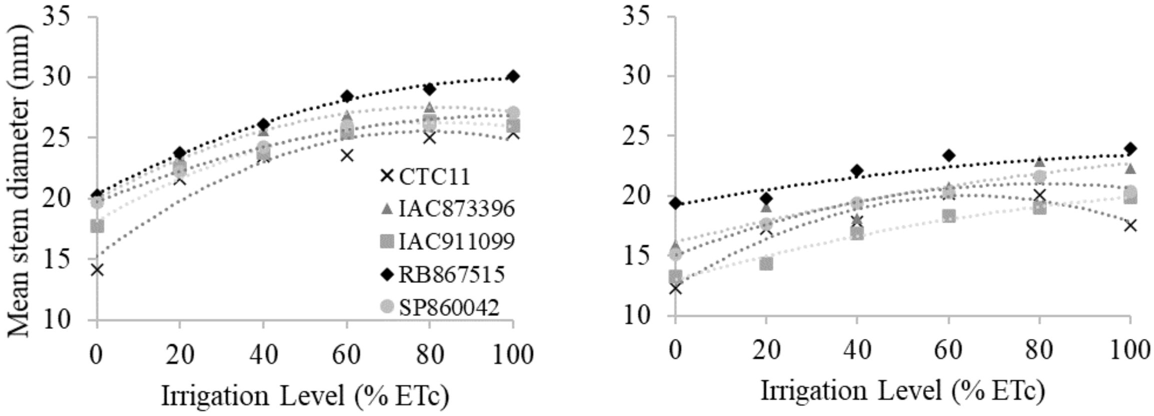

Figure 2. Mean stem diameter (mm) in function of supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of ETc in the 1st (left) and 2nd (right) year of assessment.

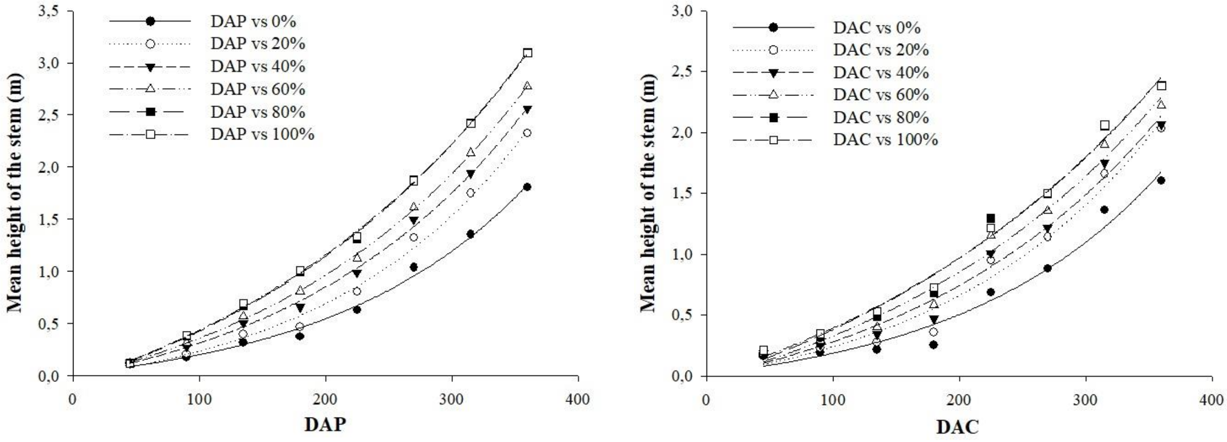

Figure 3. Mean height of the stem (cm) in function of days after planting (DAP - 1st year) and days after cutting (DAC - 2nd year) at supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of the ETc.

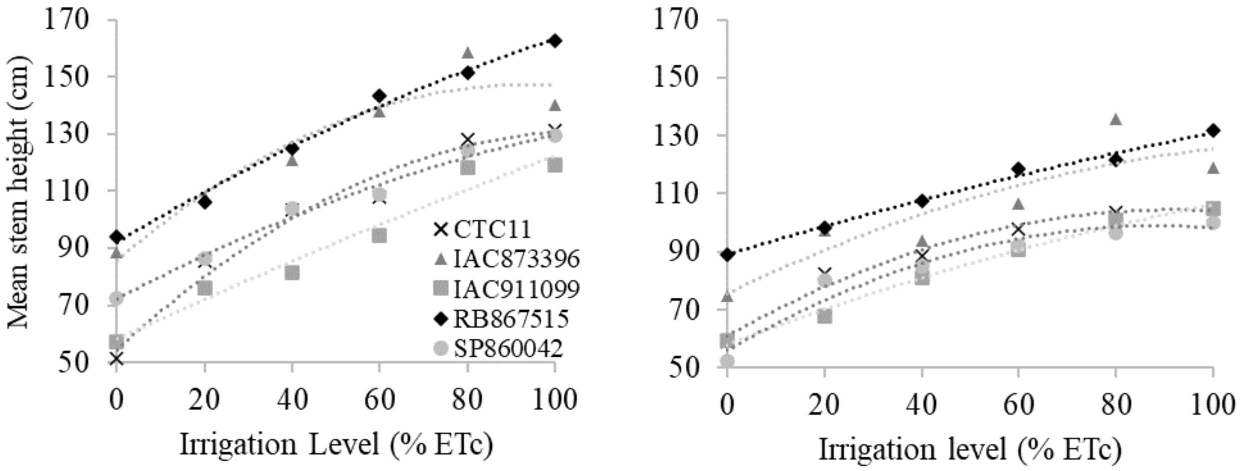

Figure 4. Mean stem height (mm) after supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of ETc in the 1st (left) and 2nd (right) year of evaluation.

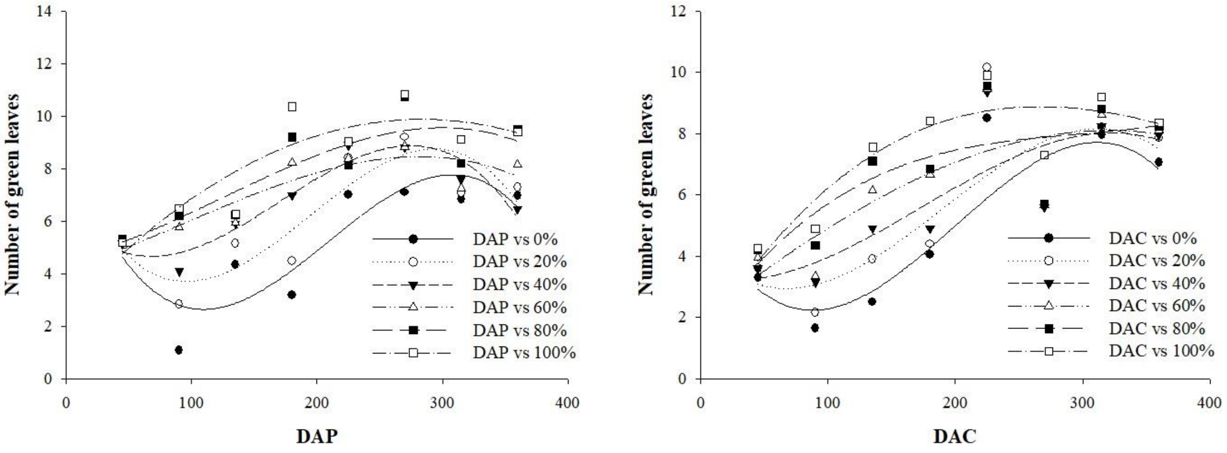

Figure 5. Number of green leaves (cm) in function of days after planting (DAP - 1st year) and days after cutting (DAC - 2nd year) at supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of the ETc.

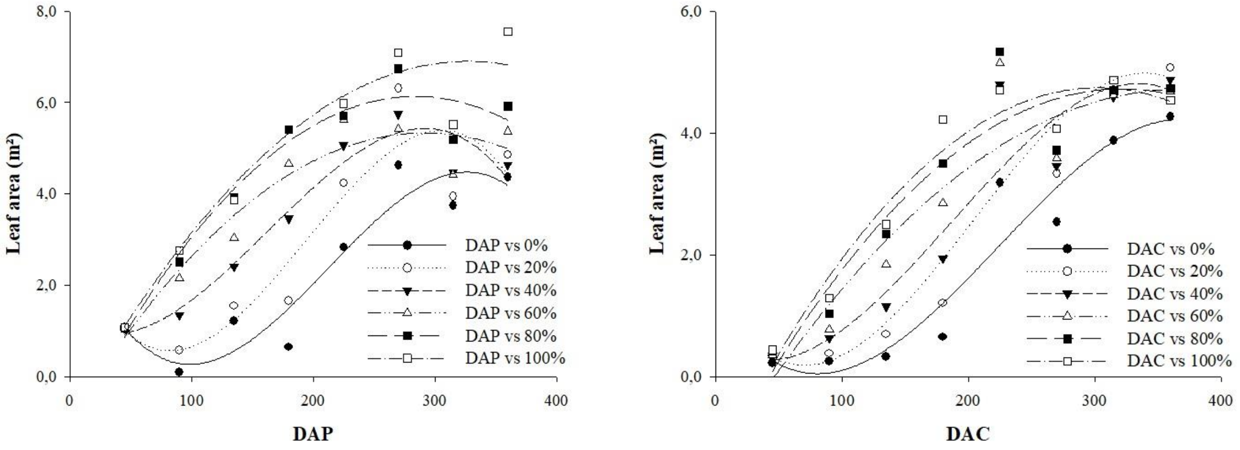

Figure 6. Leaf area (m^2) in function of days after planting (DAP - 1st year) and days after cutting (DAC – 2nd year) for supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of the ETc.

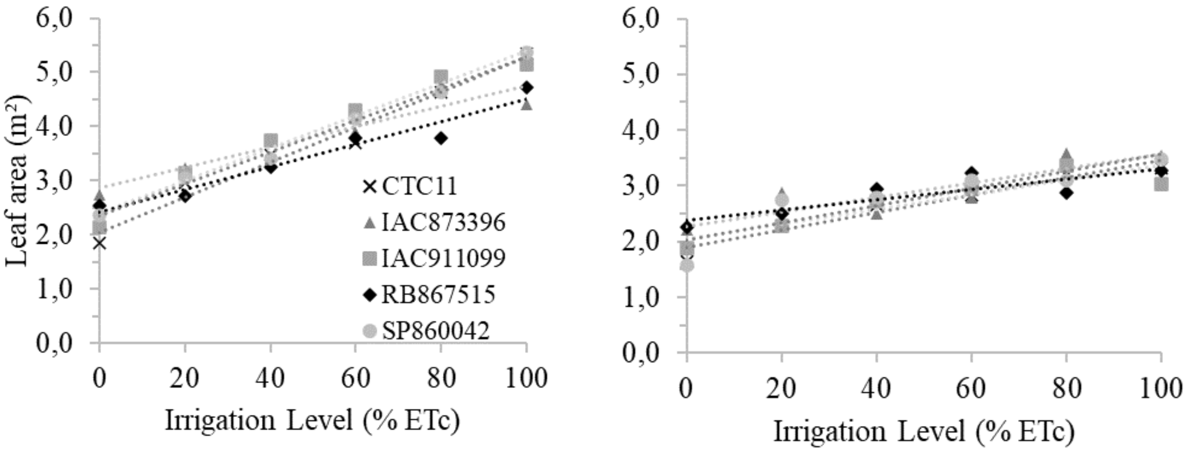

Figure 7. Leaf area (m^2) after supplementary irrigation levels of 100, 80, 60, 40, 20 and 0% of ETc in the 1st (left) and 2nd (right) year of evaluation.

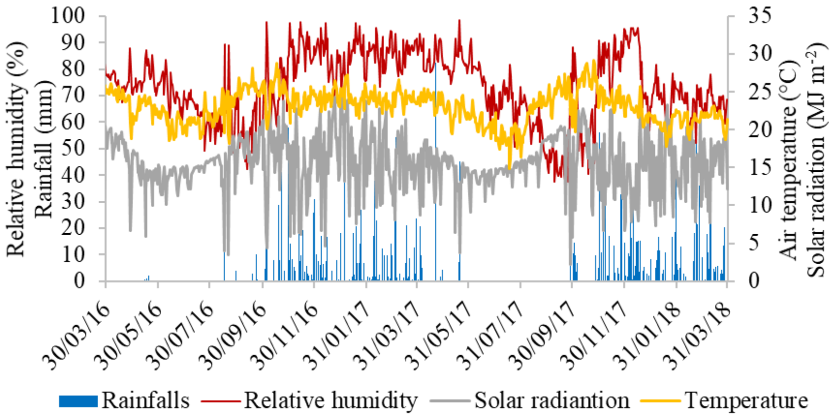

Figure 8. Climatic behavior represented by rainfalls (mm), incident solar radiation (MJ m^{-2}), average air temperature (°C), and average relative humidity (%) in Goiânia, GO, Brazil.

metabolic expense for the maintenance of tissues (Inman-Bamber et al., 2008; Pincelli and Silva, 2012). There is a higher energy expenditure, where plants keep the green leaves under water deficient conditions, which results in less dry matter accumulation, reducing plant growth and development (Holanda et al., 2014). Figure 7 shows, that the LA of varieties has an increasing linear behavior due to the increase in SIL, in both years of evaluations. On average, the IAC911099 variety presented the highest LA (3.90 m²) in the first year of evaluation, while RB867515 variety showed the lowest LA (3.47 m²). During this period, the LA caused by the SIL of 100% was higher than the SIL of 0% in 53.6%. In the second year, the variety that presented the highest LA on average (2.92 m²) was IAC873396, while the lowest LA (2.62 m²) belonged to CTC11. In this period, we found that the LA after SIL of 100% was 42.6% higher compared to that of 0%. The dynamics of leaf development usually depends on crop and of genotype, as each behaves differently in the cultivation environment (Oliveria et al., 2007; Machado et al., 2009; Pincelli and Silva, 2012). As observed for the first year of evaluation, RB867515 had smallest LA. However, it promoted the highest stem height for most SIL, as shown in Figure 4.

Technological quality of sugarcane

Table 2 shows results of technological analysis for the study variables. Through these evaluations, it appears that interaction of the tested variation factors (variety and SIL) did not influence the quality of the sugar cane juice. However, the interaction between year and supplementary irrigation led to changes in the Pol and °Brix. Pol and °Brix are indicators of sucrose index in the stem. According to ORPLANA (2013), rules, sugarcane must have a sucrose content (pol%cane) greater than 12.26% at the beginning of harvest. Thus, for SIL above 60% of ETc, the physiological maturation of sugarcane was anticipated in the first year of evaluation. However, we noted that the SIL of 0 and 20% of ETc were insufficient for production of good quality raw material.

For SILs higher than 60% of ETc, the varieties that obtained Pol higher than 12.26%, in the first year were IAC873396, RB867515 and SP860042. However, all varieties showed Pol higher than recommendation in SIL of 80 and 100% of ETc (first year). In both cases, °Brix was greater than 17%.

For all varieties and SIL (except to 0% of ETc in first year), the purity observed in the two years of evaluation, were minimum levels acceptable by industry, 85%. The higher rates of SIL caused increase in sucrose index, regardless of the variety. Silva et al. (2014), observed that higher water availability improves progressive sucrose accumulation in isodiametric cells of the stem parenchymal tissue, reflecting positively on juice purity.

The above authors found over 88% purity in two years of evaluation for IAC911099 and RB867515 varieties. In our study, however, only IAC873396 variety exceeded this value in both years. Campos et al. (2014), evaluated different varieties of sugarcane in the Cerrado and found an average purity value of 80%, 9% lower than found in our study.

The FC found in our study were 8.5 and 13.5% higher than recommended by industry for first and second year, respectively. The FC increases the resistance to extracting the juice, therefore lower values are recommended. The SP860042 and IAC873396 varieties presented the worst values. However, these varieties presented good quality of raw material (other technological characteristics). For Simões et al. (2015), Oliveira et al. (2011) and Silva et al. (2014), the FC above 13% indicated good quality in sugarcane.

Reducing sugars (TRS) are color precursors, reducing the quality of the raw material. Therefore, the ideal value is lower than 0.80%. In our study, all varieties and SIL showed on average 52.4% of the values lower than 0.8%. So, the increase in water availability favored the reduction of the color of sugar, in both years evaluated.

In general, from the first to second year of evaluation, there was an improvement in quality of sugarcane raw material evaluated. Note that the varieties IAC911099 and SP860042 presented the lowest quality indexes in first and second year, respectively. The varieties RB867515 and IAC873396 presented the highest indicators of quality in both years.

Discussion

The sugarcane growth can be divided in three phases, a) initial phase, with slow growth; b) phase of rapid growth, with appearance and lengthening of internodes (75% of total dry matter accumulates); and c) final phase, slow growth (Oliveira et al., 2010).

Stem diameter expansion was occurred in greater intensity in first four months of sugarcane development. During same period, height of sugarcane represented only 20% of total. The MSD showed a difference of less than 10% between SIL of 100 and 40% of ETc in both years. Therefore, the Cerrado environmental conditions from March to August caused a slow plants growth, even with full irrigation.

There is a consensus among studies in different regions of Brazil, such as, Machado et al. (2009) in southeast region, Abreu et al. (2013) and Silva et al. (2012) in northeast, demonstrating the period of greater insolation, irradiance and temperature associated with water availability increase greater plants height. Sugarcane plant has C4 methabolism, with highly efficient in converting radiant energy into chemical energy, favoring plants growth (Ghannoum, 2009).

The greatest plants growth occurs between December and April, with leaf area index of 4.0 enough to intercept around 95% of incident solar radiation (Oliveira et al., 2007). This justifies the exponential increase in stem height, mainly to treatments received 20 and 40% SIL in initial development phase. The photosynthetically active LA was stabilized during the period of greatest water, thermal and luminous availability.

Therefore, replacement of total water demand is unnecessary in this period, as sugar cane does not have an accelerated growth due to unfavorable environmental conditions. However, in subsequent period, it is important to replace maximum water demand, to provide plant growth accelerated, and high final production.

Technological attributes were analyzed in the end of cycle and it was possible to obtain an advance in physiological maturation of cane-plant to 12 months to all varieties irrigated with SIL of 80 and 100% of ETc.

The highest values of technological attributes are associated with full irrigation management, since intensifies elongation of stem and anticipates physiological maturation of sugarcane, increasing sucrose levels in cells, as observed by Oliveira et al. (2011).

Materials and methods

Characteristics of experimental area

This study was carried out in the experimental area of the Federal University of Goiás (UFG) in the city of Goiânia, state of Goiás, Brazil, at an altitude of 741 m, latitude 16°41' S, and longitude 49°16' W. According to the Köppen classification, the region's climate is Tropical Aw, hot and semi-humid, with a well-defined dry period during the year.

The monitoring of climatic variables (Figure 8) was carried out through the automatic meteorological station of the School of Agronomy at UFG, located 300 m from the experimental site. During the entire experimental period, between 03/30/2016 and 03/30/2018, a rainfall of 2,381 mm was recorded. The average daily temperature and relative humidity were 23 °C and 70%, respectively, and the average incident solar radiation was 15 MJ m^{-2}.

Experimental design and treatments

The experiment was completely randomized in a 5 x 6 factorial design comprising 30 treatments and four replications, totaling 120 experimental units. The treatments were five varieties of sugarcane (RB867515, CTC11, SP860042, IAC873396, and IAC911099) and six levels of supplementary irrigation (100, 80, 60, 40, 20 and 0% of the ETc). Two sugarcane cultivation cycles were evaluated, namely plant-cane (1st year) and ratoon cane (2nd year).

Experimental conduction

The experiment was installed in 120 plastic pots of 200 L (0.85 m high and 0.55 m internal diameter), arranged in eight rows with 15 pots each, spaced 0.2 m between pots and 1.5 m between lines, with five meters of border at the extremities of the area.

The pots were filled with a 0.65 m layer of soil mixture (Dystrophic Red Latosol) + peat (black soil with tanned manure) + coarse sand at a proportion of 7:2:1; and a drainable layer of 0.15 m made of a permeable geotextile blanket and gravel.

The soil was enriched with 250 g of limestone to raise the base saturation to 50%, 12 g of P_2O_5, 23 g of N and 30 g of K_2O, according to the recommendation for crop (Rosseto et al. 2008). In the first year we applied 25 g N and 40 g of K_2O, distributed per pot as cover fertilization. In the second year, 30 g of P_2O_5, 40 g of N, and 20 g of K_2O were applied per pot at beginning of regrowth.

The irrigation system was localized using self-compensated button-type drippers with a flow of 2 L h^{-1}. For the ETc levels of 100, 80, 60, 40, 20 and 0%, were used five, four, three, two, one and no drippers, respectively.

Three weighing lysimeters were installed in the experimental area. They consisted of an electronic scale with a weighing platform, with a maximum capacity of 500 kg and an accuracy of 0.050 kg. The weighing platforms were connected to a data acquisition system (datalogger).

The ETc was defined by daily difference in mass variation data on weighing lysimeters. From the average of the three lysimeters, the irrigation time was determined for the treatment of 100% of ETc. The other treatments received a blade proportional to the number of drippers for each time. Irrigation was carried out three times a week.

Determination of biometric and technological analysis of sugarcane

Biometric analyses of sugarcane were carried out over 45 days. They started 45 days after planting, when tillers were thinned out, maintaining four plants per pot until the end of the experiment. The mean stem diameter (MSD), mean height of the stem (MHS), number of apparent green leaves (NAGL), and length (L+3) and width (W+3) of the leaf +3, Kuijper system, were verified according to the methodology described by Marafon (2012). All measurements were performed on two previously selected plants from each pot.
The leaf area was determined according to the methodology of Hermann and Câmara (1999), as follows:

$$LA = A\ C\ L\ (NAGL+2) \qquad 1$$

Where LA is the leaf area (m^2), L is the leaf +3 length (m), W the leaf +3 width (m), A is the leaf shape factor, being 0.69 for the RB867515 (Trenti et al., 2011) and 0.75 for the other varieties (Hermann and Câmara, 1999), and NAGL is the number of open (apparent) green leaves.
After the harvest, the following technological variables were analyzed: mass of the humid bagasse, soluble solids content of the juice (ºBRIX, in %), sugarcane sucrose content (POL of the juice, in %), PURITY of juice, FIBER of sugarcane, and total reducing sugars (TRS) (Consecana, 2005).

Statistical analysis

The variables obtained were subjected to analysis of variance by F test at an error probability of 5%. When there was significant difference between treatments, their means were subjected to regression analysis. In all the statistical procedures, the SISVAR 5.6 software was used (Ferreira, 2014).

Conclusions

For the experimental conditions of this study, the varieties that most adapted to Cerrado environmental were, in decreasing order, RB867515, IACA873396, IAC911099, CTC11, and SP860042. The level of supplementary irrigation using greater technical viability for the cultivation of sugarcane in the Cerrado is 60% of the ETc.

Acknowledgments

To CAPES and CNPq for grants of scholarships and FAPEG for financial support.

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