

Forage yield of *Urochloa* cultivars in a warm sub-humid environment

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ABSTRACT

Objective: To evaluate for 10 weeks the growth of five *Urochloa* cultivars: Camello, Cobra, Cayman, Convert 330, Mavuno and Xaraés; during the North Winds (NS), Dry (DS) and Rainy (RS) seasons in a warm sub-humid environment.

Design/Methodology/Approach: The variables were crop growth rate (CGR; kg ha⁻¹ d⁻¹) and total dry matter yield (TDM; t ha⁻¹); which were analyzed under a completely randomized design (Tukey; p=0.05).

Results: During NS, Mavuno and Xaraés presented, on average, the highest values of CGR (p<0.05), 23.7 and 19.4 kg ha⁻¹ d⁻¹, respectively. In DS the cultivars Xaraés, Convert 330, Mavuno, and Cayman presented the highest values, with 20.7 and 26.8 kg ha⁻¹ d⁻¹, in week 2 and 4, respectively. During RS, in the second and fourth week of regrowth, the Xaraés and Mavuno cultivars presented the highest CGR (p<0.05), 119.8 and 144.7 kg ha⁻¹ d⁻¹, on average. In the NS, the Mavuno hybrid presented the highest yields (p<0.05) of TDM, 0.886, 1.553 and 2.156 t ha⁻¹ in week 6, 8 and 10, respectively. For RS, the cultivars Camello, Cayman, Mavuno, and Xaraés presented similar yields of TDM; which, on average, were 4.652, 5.312 and 6.278 t ha⁻¹, at 6, 8 and 10 weeks, respectively.

Findings/Conclusions: The cultivars Xaraés, Mavuno and Cayman presented good forage potential in a warm sub-humid environment; mainly for showing greater growth and accumulation of total dry matter.

Key words: *Brachiaria* hybrid, *Urochloa* hybrid, growth rate.

INTRODUCTION

The state of Hidalgo dedicates nearly 11% of its territory (233,000 ha) to livestock production; where the area destined for cattle, sheep and goats is 218,000, 10,000 and 5,000 ha, respectively (INEGI, 2018). On the other hand, the state of Veracruz dedicates about 3.4 million ha (48% of the state territory) to livestock, where 99% of the surface is for bovine

production (INEGI, 2018). Both states have a livestock vocation, and in addition, they share a territorial limit and therefore the climatic conditions in the northeast of Hidalgo and north of Veracruz are similar. In this region, the climate is semi-warm with abundant rains in summer (>1,200 mm per year) and temperatures above 15 °C (INEGI, 2017), conditions that allow tropical forage grasses to present high growth rates, which is reflected in higher forage yield (Santos *et al.* 2014). However, animal production is affected by the variation in forage yield during the year, since there is a shortage during the dry season and surpluses in the rainy season.

In the humid tropical region there are three well-defined seasons: the rainy season, when the precipitation is greater and together with the temperature they contribute to the active growth of forages; the dry season, when the yield is drastically affected by hydric stress due to lack of water in the soil; and the north winds season, when there is high cloudiness and a decrease in temperature, so the growth of tropical species is affected (Hernández *et al.*, 1990; Martínez *et al.*, 2008). Photosynthesis and the accumulation of dry matter are closely associated with photosynthetically active radiation (Mishra *et al.*, 2010), so that cloudiness could affect these processes; in addition to this, the minimum threshold temperature of most tropical grasses is 15 °C (Berone, 2016), although some *Urochloa* cultivars such as Xaraés and Insurgente have lower minimum threshold temperature, 12.4 and 10.5 °C, respectively (Silva *et al.*, 2012).

The forage yield of *Urochloa* cultivars ranges between 11 and 15 t ha⁻¹ year⁻¹ and said production is not constant throughout the year, since it depends mainly on environmental conditions (Garay *et al.*, 2017); therefore, the annual forage yield is presented at 72, 18 and 10%, during the rainy, north winds and dry seasons, respectively (Martínez *et al.*, 2008). It has been reported that the most recent hybrids of the genus *Urochloa* present greater potential for forage production and higher nutritional value (protein and digestibility) (Pizarro *et al.*, 2013; Vendramini *et al.*, 2014). It is important that before introducing a new forage material to any production system, the productive behavior should be evaluated in a controlled manner to determine if it is an option for livestock production in the region. Therefore, the objective of this study was to evaluate the dynamics of forage growth and production of *Urochloa* cultivars

in the north winds, dry and rainy seasons in a warm sub-humid environment.

MATERIALS AND METHODS

Location of the Experimental Site and Climatic Characteristics

The study was carried out in seasonal conditions from November 2018 to August 2019, at the Huejutla Technological Institute, located on the Huejutla-Chalahuiyapa Highway, km 5.5. Huejutla de Reyes, Hidalgo, Mexico. The geographical coordinates are 21° 9' 19.66" N and 98° 22' 11.02" W, at 112 meters above sea level. The climate is classified as warm sub-humid [Ax₂(x)]; García, 2004] with abundant summer rains mean annual temperature that ranges between 24 and 26 °C (INEGI, 2017). In this place there are three well-defined seasons: dry, rainy, and north winds (Figure 1; SMN, 2020).

Treatments and Management of the Experimental Plots

The evaluated treatments (cultivars) were five hybrids of *Urochloa*: Camello, Cobra, Cayman, Convert 330 and Mavuno, and one variety (*U. brizantha* cv. Xaraés). They were evaluated for 10 weeks during the north winds, dry and rainy seasons. These cultivars were sown with botanical seed (05/11/2018) in streams in rows at 0.3 m distance in experimental plots of 16 m² (4×4 m).

Prior to sowing, a germination test was carried out and the sowing dose was determined for each treatment (4 kg ha⁻¹ of viable pure seed); for this purpose, representative samples of the seed were taken from each

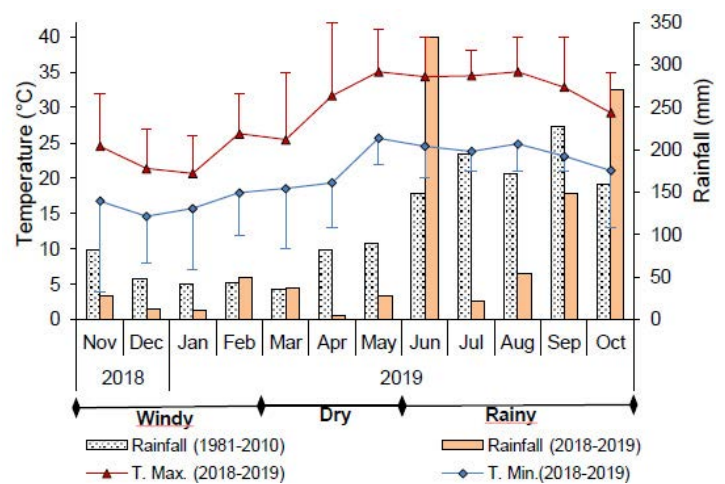


Figure 1. Monthly accumulated precipitation (Preci.) and maximum (Max. T.) and minimum (Min. T.) temperature during the period 2018-2019, in Huejutla de Reyes, Hidalgo. Average information of 29 years (1981-2010). Source: SMN (2020).

genotype, and a trial was set up with four repetitions of 100 seeds for each genotype, which were put on newspaper, moistened daily and the germinated seeds were counted, with which the germination percentage was calculated. There was an establishment period of 6 months, in which two uniformity cuts were made at 15 cm above ground level to stimulate clustering and a rapid establishment of the meadows. Before starting with the sampling in each season, a uniformity cut was made at 15 cm above the ground and then five samplings were carried out every two weeks. At the center of the furrow, the forage present was harvested periodically in a linear meter (experimental unit). The harvested forage was weighed and a 200 g subsample was taken, later it was placed in a forced air stove at 65 °C for 72 h to dry. The subsamples were weighed before and after drying to determine the dry matter content.

Variables Evaluated and Statistical Analysis

With the values of the dry matter content, calculations were carried out to determine the accumulation of total dry matter (TDM; t ha⁻¹) using the formula proposed by Hunt (1990) to estimate the CGR (kg ha⁻¹ d⁻¹). The variables were analyzed with the GLM procedure by SAS (2003) in a completely randomized design with four repetitions, in an arrangement of measurements repeated over time. The means comparison was carried out using the Tukey test (p=0.05).

$$Y_{ijk} = \mu + C_i + \delta_{i(j)} + S_k + (CS)_{ik} + \varepsilon_{ijk}$$

Where: Y_{ijk} =response variable; μ =general mean; C_i = effect of the cultivar; $\delta_{i(j)}$ =error associated

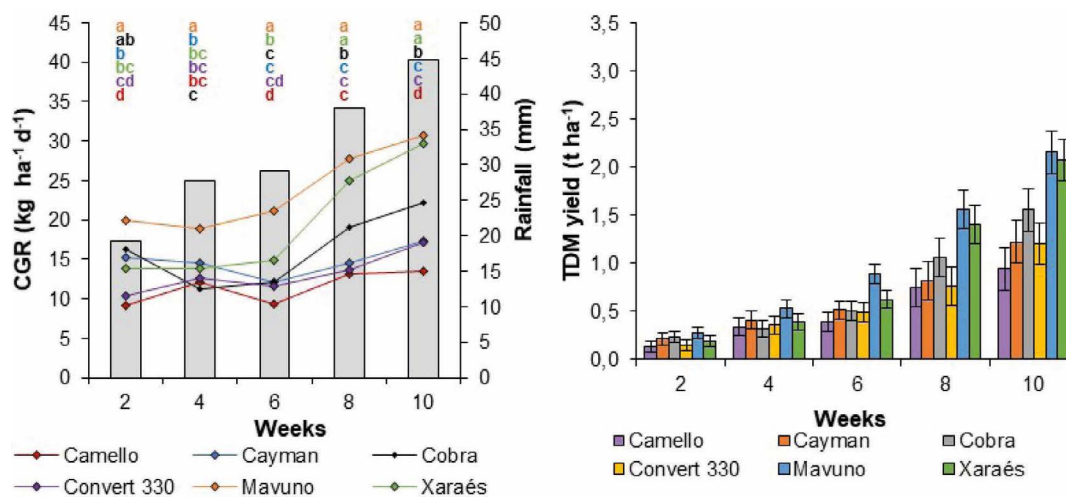


Figure 3. Crop growth rate (CGR) and total dry matter yield (TDM) of cultivars of the genus *Urochloa* during the north winds season in Huejutla de Reyes, Hidalgo. Different letters between cultivars (a, b, c, d) and the bars in each regrowth age indicate a statistically significant difference (Tukey; p=0.05).

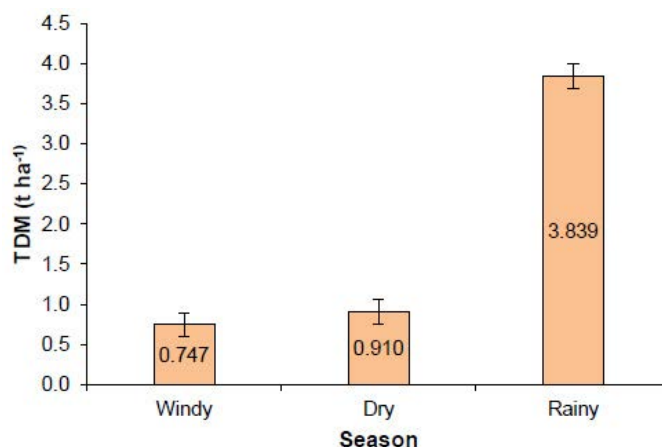


Figure 2. Total dry matter yield (TDM) during the north winds, dry and rainy seasons in Huejutla de Reyes, Hidalgo. The bars represent the least significant difference (Tukey; p=0.05).

with cultivars; S_k =effect of the sampling week; $(CS)_{ik}$ =interaction between the cultivar and the sampling week; ε_{ijk} =experimental error associated with the sampling week.

RESULTS AND DISCUSSION

It was observed (Figure 2) that the forage yield was higher (p<0.05) during the rainy season, 3,849 t ha⁻¹, on average. In contrast, yields were lower (p>0.05) during NS and DS (0.747 and 0.910 t ha⁻¹, respectively).

During the NS (November-January) it was observed that the accumulated precipitation was 45 mm, which was 74% lower (Figure 3), compared to the average accumulation of 29 years (1981-2010) for the same season (173 mm; SMN, 2020). During this season it was observed that the average maximum and minimum

temperatures were 22 ± 6 and 16 ± 9 °C, respectively (Figure 1). In this season, the evaluated cultivars presented different growth dynamics, where Mavuno and Xaraés presented on average the highest values of TCC ($p<0.05$), 23.7 and 19.4 $\text{kg ha}^{-1} \text{d}^{-1}$, respectively. In contrast, the Camello, Convert 330 and Cayman cultivars had the lowest CGR, with 11.5, 13.1 and 14.8 $\text{kg ha}^{-1} \text{d}^{-1}$, respectively. The average CGR during the NS was 14.1, 13.9, 13.5, 18.9 and 21.8 $\text{kg ha}^{-1} \text{d}^{-1}$ at 2, 4, 6, 8 and 10 weeks, respectively (Figure 3).

The average yield of total dry matter (TDM) during the NS was 0.198, 0.389, 0.567, 1.057, 1.525 t ha^{-1} at 2, 4, 6, 8 and 10 weeks, respectively. Differences were only observed between the cultivars from the sixth week, where the hybrid Mavuno presented the highest yields ($p<0.05$) of TDM, 0.886, 1.553 and 2.156 t ha^{-1} in week 6, 8 and 10, respectively. The Xaraés cultivar only equaled Mavuno at the eighth and tenth weeks. Meanwhile, the hybrid Cobra presented similar yields of TDM that Xaraés. The cultivars that

presented the lowest TDM yields during the NS were Cayman, Camello and Convert 330 (Figure 3).

During the DS (March-May) the accumulated precipitation was 35 mm, which was below 83% (Figure 4) of the average reported for the same season in the study area (207 mm; SMN, 2020). During this season it was observed that the average maximum and minimum temperatures were 31 ± 9 and 21 ± 6 °C, respectively (Figure 1). During this time, the CGRs were 15.4, 21.8, 19.2, 18.9, 26.5 $\text{kg ha}^{-1} \text{d}^{-1}$ at 2, 4, 6, 8 and 10 weeks, respectively. There were only differences between the cultivars evaluated in the second and fourth week of regrowth ($p<0.05$), when the Xaraés, Convert 330, Mavuno and Cayman cultivars presented the highest values (on average), with 20.7 and 26.8 $\text{kg ha}^{-1} \text{d}^{-1}$, respectively (Figure 4). On the other hand, the Camello cultivar presented the lowest CGR ($p<0.05$) in the same cutting dates, 5.3 and 8.5 $\text{kg ha}^{-1} \text{d}^{-1}$, respectively. From the sixth to the tenth week, all cultivars presented similar ($p>0.05$) CGR (Figure 4). In this season, only significant differences ($p<0.05$) were observed between the cultivars for the TDM variable in the fourth, eighth and tenth weeks. The most outstanding were Cayman (meaning week 10), Cobra (meaning week 4), Convert 330, Mavuno and Xaraés (Figure 4), which on average presented 0.685, 1.145 and 1.935 t ha^{-1} at 4, 8 and 10 weeks, respectively. In contrast, the Camello hybrid was the one that presented the lowest TDM values, 0.237, 0.618 and 1.469 t ha^{-1} , respectively, for the aforementioned regrowth ages. The TDM yield for this season was 0.216, 0.610, 0.808, 1.057 and 1.857 t ha^{-1} at 2, 4, 6, 8 and 10 weeks, respectively (Figure 4).

During the rainy season (June-August) the accumulated precipitation was 304 mm, which was 41% lower, compared to the average reported for the same season (517 mm) in the place where the evaluation was carried out (SMN, 2020). Likewise, it was observed that the average maximum and minimum temperatures were 35 ± 5 and 24 ± 4 °C, respectively (Figure 1). During this season the highest growth dynamics was observed in the

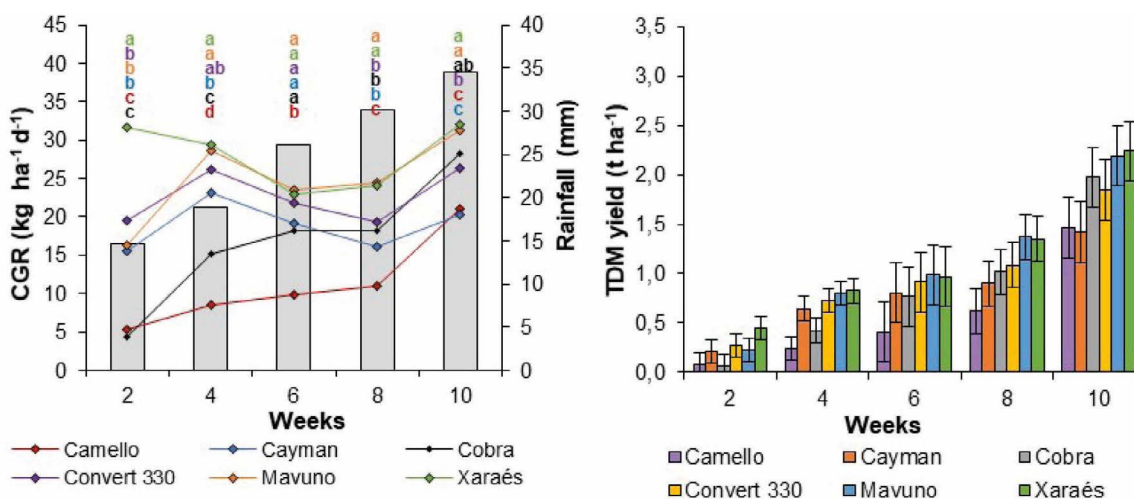


Figure 4. Crop growth rate (CGR) and total dry matter yield (TDM) of cultivars of the *Urochloa* genus during the dry season in Huejutla de Reyes, Hidalgo. Different letters between cultivars (a, b, c, d) and the bars at each regrowth age indicate a statistically significant difference (Tukey; $p=0.05$).

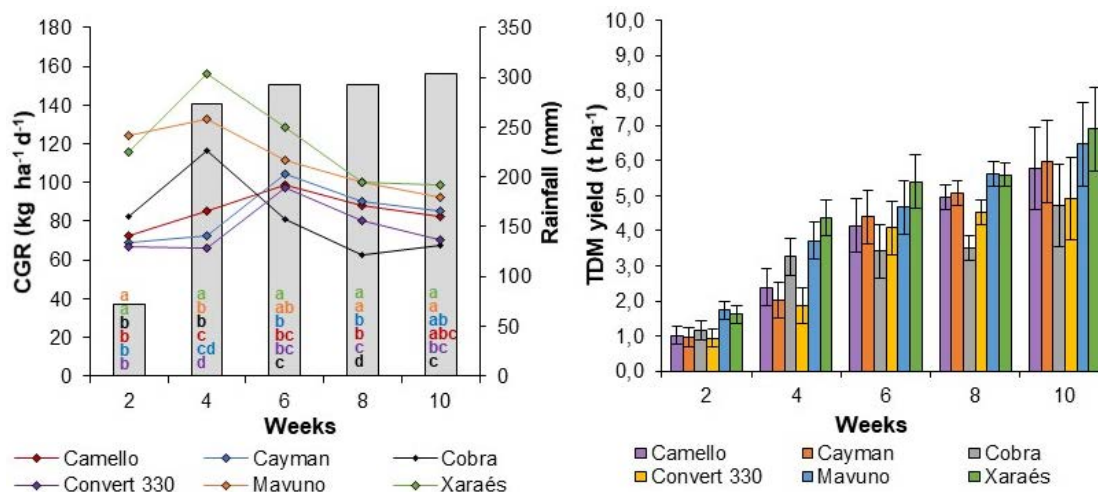


Figure 5. Crop growth rate (CGR) and total dry matter yield (TDM) of cultivars of the *Urochloa* genus during the rainy season in Huejutla de Reyes, Hidalgo. Different letters between cultivars (a, b, c, d) and the bars at each regrowth age indicate a statistically significant difference (Tukey; $p=0.05$).

grasses evaluated. In this sense, the CGRs were 88.4, 105.0, 103.6, 87.1, 82.7 $\text{kg ha}^{-1} \text{d}^{-1}$ at 2, 4, 6, 8 and 10 weeks, respectively. In the second and fourth week of regrowth, the Xaraés and Mavuno cultivars presented the highest CGRs ($p < 0.05$), which on average were 119.8 and 144.7 $\text{kg ha}^{-1} \text{d}^{-1}$, respectively (Figure 5).

On the contrary, Camello, Convert 330 and Cayman, presented the lowest values in the CGR ($p < 0.05$), which, on average were 69.5 and 74.7 $\text{kg ha}^{-1} \text{d}^{-1}$, respectively, for the aforementioned regrowth ages (Figure 5). It should be noted that the Cobra cultivar, during the first two regrowth ages (2 and 4 weeks), presented CGR similar to those of Xaraés and Mavuno; however, from the sixth to the tenth week, these values decreased considerably, ranging between 62.7 and 81.2 $\text{kg ha}^{-1} \text{d}^{-1}$. The greater growth dynamic observed during the rainy season was reflected in the greater accumulation of TDM. In this sense, yields of 1,238, 2,939, 4,350, 4,880 and 5,790 t ha^{-1} were obtained at 2, 4, 6, 8 and 10 weeks, respectively. At 2 and 4 weeks of regrowth, the Xaraés and Mavuno cultivars presented the highest TDM yields ($p < 0.05$), with values (on average) of 1,677 and 4,051 t ha^{-1} , respectively. From the sixth week on, the Camello, Cayman, Mavuno and Xaraés cultivars presented similar TDM yields, which, on average, were 4,652, 5,312 and 6,278 t ha^{-1} , respectively (Figure 5).

The CGR or absolute growth rate (AGR), is the increase in the dry matter of the plant or of each of its organs per unit area that it occupies in the soil, per unit of time (Hunt, 1990), behavior which was observed in Figures 3

to 5. The reduction in CGR during NS and DS was the result of the low availability of moisture (45 and 35 mm, respectively). In addition to this, during the NS there were minimum temperatures that were below 10 °C (Figure 1), which affected the growth of the grasses. It has been documented that in tropical grasses, as is the case of the grasses evaluated in this study, when the temperature falls below 15 °C, respiration and photosynthesis are interrupted, thus inevitably stopping plant growth (Durán et al., 2011). In contrast to the two seasons mentioned above, during the rainy season there was greater growth dynamics. This was mainly influenced by the availability of moisture (304 mm of precipitation) and the relatively high temperatures, which were 24 and 35 °C, average minimum and maximum temperatures, respectively; these conditions favored active growth of the forage (Cruz et al., 2011; Martínez-López et al., 2014; Santos et al., 2014).

Temperature is a factor that directly affects the growth of plants. The minimum threshold temperature of most tropical grasses has been reported to be 15 °C (Durán et al., 2011; Berone, 2016). However, it has been reported that the Xaraés cultivar presents a minimum threshold temperature of 12.4 °C (Silva et al., 2012), a characteristic that allowed it to have higher CGR and accumulation of TDM during NS. The growth of the *Urochloa* cultivars was affected by the conditions that were present during the north winds season; mainly, a decrease in temperature and high cloudiness (Hernández et al., 1990; Martínez et al., 2008). The latter directly affects the photosynthesis process, since it is closely

related to photosynthetically active radiation (Mishra *et al.*, 2010), which was reflected in the lower accumulation of CGR. The highest growth dynamics occurred during the RS, as a result of the active growth of the grass (Castro *et al.*, 2013). Likewise, during this season there was an increase in the temperature, which accelerates the growth of the plant and this can cause senescence of the forage to be earlier (Santos *et al.*, 2014). In addition, during this season, there was greater availability of humidity, and also temperatures above 18 °C, which allowed the growth of the grasses. It has been indicated that in order not to affect the growth of forage grasses, in addition to the humidity present in the soil, there should be temperatures above 15 °C, which is the minimum threshold temperature of most tropical grasses (Mendonça and Rassini, 2006; Durán *et al.*, 2011). The forage production of cultivars of the *Urochloa* genus was variable during the year, since it depended on the environmental conditions present during each season. It has been reported that the annual forage production of this genus is distributed as follows in the three seasons: from 13 to 22% in the NS, from 8 to 12% in the DS, and from 66 to 79% in the RS (Martínez *et al.*, 2008; Cab *et al.*, 2008); which are similar to the yields reported in this study.

CONCLUSIONS

In the conditions where the experiment was carried out there are difficulties for forage production, mainly during NS and DS. The Xaraés, Mavuno and Cayman cultivars showed greater growth and accumulation of total dry matter; therefore, they can be an option for

the livestock production that is carried out in warm sub-humid conditions. It is worth mentioning that this evaluation was only carried out during the period of one year, which was atypical compared to the average values of the climatological events for the place of study.

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