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PHYSICAL-CHEMICAL QUALITY OF Urochloa GRASSES IN DIFFERENT PHENOLOGICAL STAGES

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ABSTRACT

The objective was to evaluate the physical-chemical quality of hybrids Urochloa (Insurgent, Piata and Signal) at different phenological stages, in the dry tropics. The evaluated variables were: total forage yield and per components, intercepted radiation, plant height and crude protein per component. A complete blocks design was used to the random with arrangement in divided plots and four repetitions, with the procedure PROC GLM of SAS. In the three grasses, the best total dry matter yield was obtained at 49 days of regrowth, with 6732 kg DM ha-1 in the Insurgent grass, Piata with 3320 and Signal presented 2675 kg DM ha-1; the leaf component presented a higher percentage of crude protein, at 14 days, reaching 22, 21 and 21% for the Piata, Insurgent and Signal grasses, respectively (P = 0.05). As the regrowth increased, the yield of total dry matter, leaf and plant height increased, on day 49 the decline began; however, the stem component and senescence increased until day 56. The percentage of intercepted radiation of 95% was on day 42 of regrowth, considering this the optimal cutting moment.

Keywords: Urochloa, forage accumulation, crude protein.

1. INTRODUCTION

The demand for food worldwide by the growing population demands changes in the agricultural field; So much that, by 2050 production must increase by 60%, using land that is already being exploited, producing more with less natural resources (Gerber et al. 2013). Grasses and forages production use 80% of agricultural soils and 8% of water; therefore, the sustainability of livestock systems requires adapting and facing climate change (Morales-Velasco et al. 2016; Steinfeld et al. 2006), seeking alternatives that improve production and using biological technologies that affect less.

The use of technological packages based on genetic improvement of native grasses species; It has allowed the use of new varieties or genotypes with better production (Morales-Velasco et al. 2016) and protein contents above 9% (Poppi and Mclennan, 1995; Rojas et al. 2018); that are alternatives for periods of low water, where the availability of native forages decreases drastically, having losses in weight gain, milk production, and soil erosion (Barhona et al. 2014; Mayren -Mendoza et al. 2018).

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All forage species, achieve a better biomass production when they are cultivated where temperatures are optimal (McKenzie et al. 1999; Muñoz-Gonzáles et al. 2016); in addition, it is demonstrated that the pastures with higher development efficiency have better nutritional quality (Cid et al. 2008). Studies show that in hybrids*Brachiaria* now *Urochloa* the crude protein content ranges between 8 and 18% (Dairy Australia, 2005) and between 7 and 19%, depending on the production conditions (fertilization, irrigation, rain, dry, etc.), from the harvest season, it is also common that in all forage species as age increases, the nutritional contents are reduced (Euclides, 2001; Gómez et al. 2000; Pérez-López and Afanador-Téllez, 2017). Rojas et al. (2018), evaluated the Cobra grass (*Brachiaria* HYBRID BR02 /1794) and found that, at 35 days of regrowth, at an intensity of 15 cm it presents 1200 kg DM ha^{-1} of dry matter in the leaf, with 21.01% crude protein. The morphological quality also increases when the plants develop in the right conditions, in rainy season the Brachiarias fertilized with Nitrogen considerably increase the height (Fagundes et al. 2006; Pérez-López and Afanador-Téllez, 2017), internode elongation, increase in the rate of leaf apparition and therefore better soil coverage (Santos et al. 1998).

Under this premise, research is required on improved species that generate sustainable alternatives to maintain the productivity of livestock systems; Because low production is associated with inefficient management of dry matter available in grasses; therefore, the objective is to evaluate the physical-chemical quality of hybrids*Urochloa* (Insurgent, Piata and Signal) at different phenological stages, in the dry tropics.

2. MATERIALS AND METHODS

Location of the experimental area: This research was carried out in the experimental unit of the Instituto Tecnológico de Pinotepa, located at kilometer 26 of the Pinotepa Nacional highway, Oaxaca - Acapulco, south of the town of San José Estancia Grande, Oaxaca, in the period from August to December 2017 and laboratory analyzes in the same experimental unit from January to June 2018.

It is located at 16º 22´ north latitude and 98º 13´ west longitude, with a height of 60 masl according to the Köeppen climate classification, it presents an Aw (w) ig climate, it corresponds to a sub-humid warm climate (García, 2004), with a summer rainfall regime. The pluvial precipitation is in a range of 1000-1500 mm per year with a rainy period from June to September with 8 months of drought, with an average temperature of 26-28 °C.

Parcel management: Planting was carried out on August 10, 2017, with pure viable seed from three grasses of the *Urochloa* genus. The sowing method was direct, at a distance between furrow and furrow of 50 cm and between plants of 20 cm. Four 10 x 5 m plots were planted, being experimental units for each grass. These are in turn in eight areas, in order to evaluate a growth analysis with eight regrowth ages. The soil with a sandy clay texture, pH 4.8 to 5.0, deficient in organic matter. The weed was controlled manually with the help of a hoe, two nitrogen fertilizations were carried out with urea (46-00-00), the first was done on September 28 and the second was on October 17, 2017. Before starting the analyzes of growth on October 20, 2017, a homogenization cut was made at a height of 10 cm in all the experimental plots. Aid irrigation was carried out by the drip method to help the good growth of the pastures every 3 days.

Variables evaluated

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Total and component forage accumulation: In each grass after the uniformization cut, every seven days two 50 x 50 cm squares were cut in each experimental plot at 10 cm height, randomly selected; the forage was separated into its leaf, stem and senescence components. It was washed, and it was deposited in a forced air stove at 55 ^{o}C until constant weight, recording the weight to estimate the dry matter per hectare, at the different cutting ages.

Intercepted radiation: One day prior to each cut, five repetition radiation readings were taken at random with the wooden meter method described by Rojas et al. (2016) in each experimental unit. The readings were made at approximately 1:00 p.m. The procedure consisted of placing the ruler on the surface of the ground (under the canopy), facing south-north, and immediately afterwards, the shaded centimeters were counted, which represented the percentage of radiation intercepted by the vegetal canopy.

Plant height: After the homogenization cut, the average height per plant was estimated weekly, one day before the evaluation, taking 20 readings at random in each experimental plot. For this, a 100 cm graduated ruler was used and the height was taken into account in the morphological component with the highest height.

Crude protein: The leaf, stem and complete plant of each sample were obtained separately from the morphological composition sample, they were analyzed in triplicate and the nitrogen content was determined and, multiplied by the constant 6.25, obtaining crude protein (AOAC, 2005).

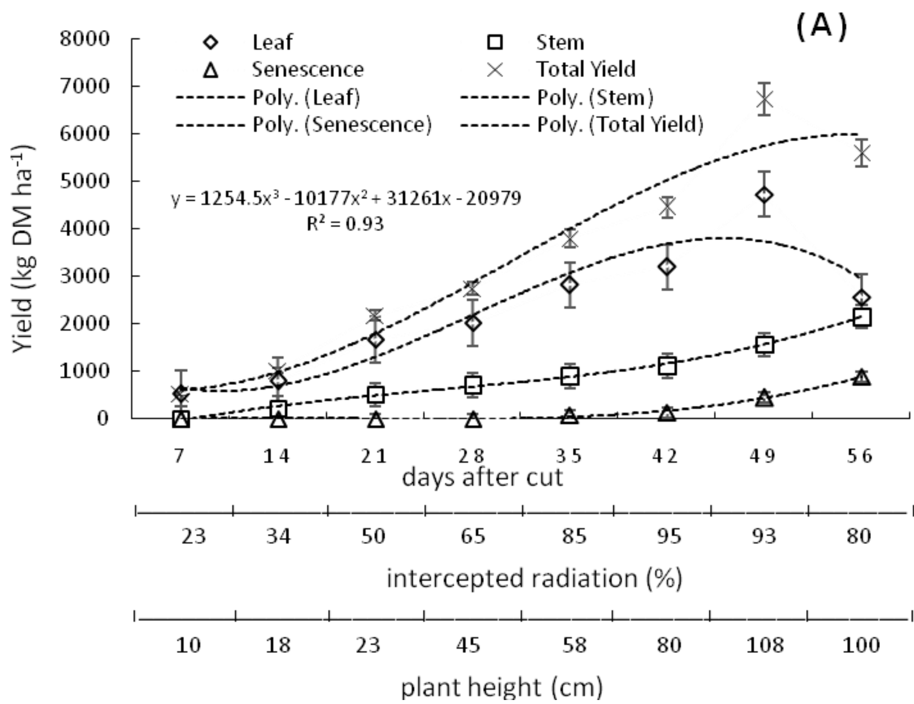
Statistical analysis: The data was analyzed using a completely randomized block design with arrangement in divided plots and four replications, the procedure used was PROC GLM from SAS (2011), where the cuting frequency effects were considered as fixed. The multiple comparison of means of the treatments was carried out using the Tukey test ($\alpha = 0.05$).

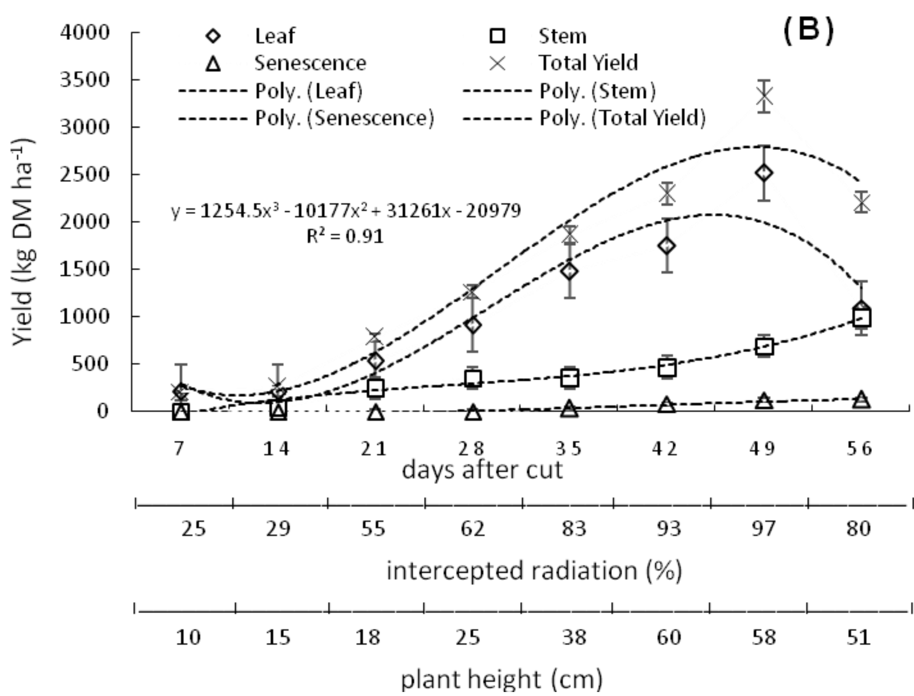
3. RESULTS AND DISCUSSION

Total and component forage accumulation

The total dry matter yield and by component are observed in Figure 1 of the Insurgent, Piata and Signal grasses by varying the phenological state of the plant. In all three grasses, the yield in the first days of growth was slow and then accelerated to subsequently decrease. The highest total dry matter yield was obtained in the three grasses, at 49 days of regrowth with 6732 kg DM ha^{-1} in the Insurgent grass followed by Piata and the lowest Signal with 3320 and 2675 kg DM ha^{-1}, respectively ($P \leq 0.05$).

Likewise, the highest proportion of leaf was reported on day 49 with 4721, 2512 and 1420 kg DM ha^{-1}, respectively for the Insurgent grass, Piata and Signal grass (Figure 1; $P \leq 0.05$), and later begin to decline as the leaves in the lower layers were senescing (Calzada et al. 2013; Rojas et al. 2018; Maldonado et al. 2019). They consignhigher senescence at a longer regrowth time for being below the compensation point of lightuntil the leaves continually die as happened in this investigation, initiating senescence on day 35 and increasing continuously until day 56, having the Insurgent grass and Piata the highest and lowest senescence with 888 and 128 kg DM ha^{-1}, respectively ($P \leq 0.05$).


(A)
Leaf
Stem
Senescence
Total Yield
Poly. (Leaf)
Poly. (Stem)
Poly. (Senescence)
Poly. (Total Yield)
y = 1254.5x³ - 10177x² + 31261x - 20979
R² = 0.93
Yield (kg DM ha-1)
8000
7000
6000
5000
4000
3000
2000
1000
0
7 14 21 28 35 42 49 56
days after cut
23 34 50 65 85 95 93 80
intercepted radiation (%)
10 18 23 45 58 80 108 100
plant height (cm)


(B)
Leaf
Stem
Senescence
Total Yield
Poly. (Leaf)
Poly. (Stem)
Poly. (Senescence)
Poly. (Total Yield)
y = 1254.5x³ - 10177x² + 31261x - 20979
R² = 0.91
Yield (kg DM ha-1)
4000
3500
3000
2500
2000
1500
1000
500
0
7 14 21 28 35 42 49 56
days after cut
25 29 55 62 83 93 97 80
intercepted radiation (%)
10 15 18 25 38 60 58 51
plant height (cm)

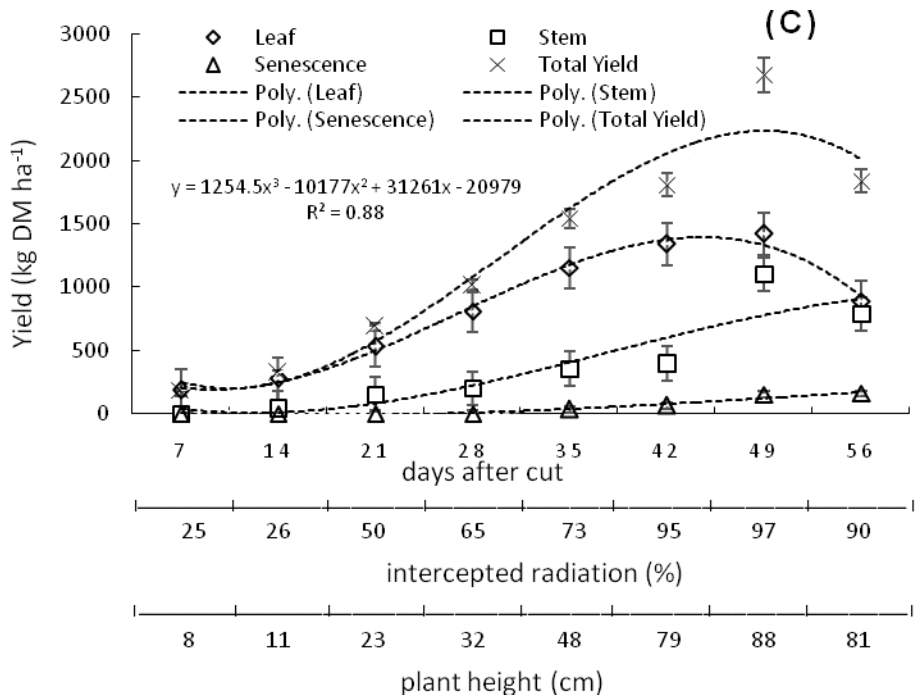


Figure 1. Total and component yield, intercepted radiation and plant height of grass Insurgent (A), Piata (B) and Signal (C) from hybrid*Urochloa* in different phenological stages.

In the case of the stem component at the beginning of the evaluation, the contribution of dry matter was null, however, It was increasingaccordingelapsedthe evaluation period until day 56, with the highest yield being the Insurgent grass followed by Piata and Signal with 2147, 989 and 787 kg DM ha^{-1}, respectively ($P \leq 0.05$). Similar trend to those of this research are reported by several researchers (Velasco et al. 2001; Rueda et al. 2016; Wilson et al. 2017) in growth analysis of different grasses where the highest yield is obtained in the sixth week regrowth tending to decrease. The higher yield reported at 49 days of regrowth could be due to the trend growth that grasses have to a slow growth, accelerated growth and with a trend to decrease as other researchers report (Rojas et al. 2016; Cruz et al. 2017a) In another investigation of the Cobra grass (hybrid *Urochloa*) Rojas et al. (2018) obtained the highest dry matter yield at 56 days at a defoliation intensity of 15 cm with 2550 kg DM ha^{-1}, related to this investigation in Piata and Signal grass.

Leaf, stem, senescence changes are variable and are influenced by the time of year, planting density, associations and monoculture (Rojas et al. 2016; Maldonado et al., 2019). On the other hand, Juskiw et al. (2000) mention that in the advanced physiological stages the yield of stem, senescence and spike is increased, decreasing the leaf, due in part to the translocation of nutrients from the leaves that results in the senescence and death of this component for filling grain, which in this case was just starting.

Intercepted radiation

Figure 1 shows the intercepted radiation from the Insurgent, Piata and Signal grasses by varying the phenological state. As the cutting frequency increases, the radiation intercepted in the three grasses increases until it reaches a maximum point and tends to decrease ($P = 0.05$). The grass

Insurgent and Signal reached on day 42 the radiation of 95% optimal cutting time according to several researchers (Da Silva and Nascimento, 2007), since this is when the best structural characteristics of the meadow are found and with the highest quality. However, the highest radiation was found at the highest cutting frequency at 49 days in Piata and Signal with 97% of radiation, which shows the trend of leaf decrease and stem increase and senescence supported by other researchers (Da Silva and Hernández-Garay, 2010) in tropical grasses. Therefore, where it is recommended to harvest the forage is when it reaches 95% of radiation intercepted in this case with the conditions and management given on day 43 after regrowth on average in the three grasses.

In this regard, Maldonado et al. (2019) reinforce the mentioned of harvesting the forage when it reaches 95% of intercepted radiation since the greatest amount of green leaves is found; For their part, other researchers (Mattera et al., 2013; Rojas et al. 2016) consign that these results are achieved when the density of plants is competitive not less than 30 plants per m^{-2}. In their investigations, Federick and Bauder, (1999) and Da silva and Hernández-Garay, (2010) report the ability of different grasses to capture solar radiation and depends on the number of plants, cutting frequency and intensity and the environmental conditions at which that were exposed during their growth.

Plant height

Figure 1 shows the height of the Insurgent, Piata and Signal grasses by varying phenological states. Independently of the grass, the height increased as well as the radiation as the evaluation period passed (P = 0.05). The highest plant height was reported in the Insurgent grass at 49 days with 108 cm coinciding with the highest total forage yield (P = 0.05). Secondly, was the Signal grass again at 49 days of regrowth with 88 cm of height and finally the Piata grass on day 42 with 60 cm (P = 0.05); being closely related to the total yield, higher contribution of the sheet and intercepted radiation of 95%. Similar results in tropical grasses obtained Calzada et al. (2014) and Rojas et al. (2018) a higher height combined with a higher yield of total dry matter and intercepted radiation up to a certain point to begin to decline.

Crude protein

Table 1 shows the percentage of crude protein of the leaf, stem and complete plant of three grasses of the genus *Urochloa*.The opposite of yield, height and radiation protein content radiation decreases as the evaluation period progresses in the three grasses and plant components. The leaf component was the one that obtained the highest percentage of crude protein in the three grasses, reporting on day 14 the highest percentage with 22, 21 and 21% of crude protein for the Piata, Insurgent and Signal grasses, respectively (P = 0.05); on day 56, the lowest percentage of crude protein in the leaf was obtained with 12, 14 and 14% for Piata , Insurgent and Signal, respectively (P = 0.05). In the stem component, the highest percentage occurred on day 14 with 15, 15 and 13 % crude protein for Insurgent, Signal and Piata, respectively (P = 0.05). Finally, the entire plant exhibited an average of 18 % crude protein in the three grasses, decreasing its crude protein content to 12% on day 56.

Table 2. Crude protein (%) by component and entire plant of three grasses of the *Urochloa* genus in a growth curve.

Grasses	Days after cut				
	14	**28**	**42**	**49**	**56**
			Leaf		
Insurgent	21a	16b	16b	15bc	14c
Piata	22a	15c	16b	15c	12d
Signal	21a	16b	16b	16b	14c
			Stem		
Insurgent	15a	13b	12c	14b	9d
Piata	13a	13a	12ab	12ab	9b
Signal	15a	13c	14b	12d	11e
			Entire plant		
Insurgent	18	15b	14b	14b	12c
Piata	17a	14b	14b	14b	11c
Signal	18	15b	15b	14c	12d

abc = Averages with the same lowercase literal in the same row, are not different (P= 0.05).

The same trends and crude protein values were reported by Castro-Salas (2014) in a hybrid*Urochloa*in the leaf component, decreasing the percentage of protein as the regrowth time increased with a content of 17.4 and 11.8% of crude protein on day 7 at 49 regrowth in Mulato II. On the other hand, Rojas et al. (2018) in Cobra grass (hybrid *Urochloa*) obtained in leaf and stem similar results to those of this study, reporting on day 21, 20% of protein in leaf and 13 % in stem and decreasing until day 63 with 7 and 4 % of protein in leaf and stem, respectively.

4. CONCLUSION

As the age of the regrowth increased, the yield of total dry matter and leaf and plant height increased until day 49, later, it begins to decline; however, the stem and senescence component were increasing until day 56. Where the percentage of intercepted radiation is 95 % is on day 42 of regrowth. In the leaf, stem and complete plant components, crude protein was higher in the younger phenological stages, decreasing as the age of the plant increased. A longer evaluation time is recommended and at different times of the year to broaden the decision landscape.

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