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# Foliar fertilizer and biostimulant to enhance performance of *Urochloa* hybrid in two different seasons

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**Abstract**

Technologies that promote forage production provide gains of income in beef cattle. The objective of this research was to evaluate forage production, morphological components and nutritive value of pasture of *Urochloa* hybrid Convert HD364, with application of biostimulant, foliar fertilizers and urea. A completely randomized design with 7 treatments and 3 replications was used. The treatments consisted of T1 (control: no fertilization), T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant). The leaf content and accumulation of macro and micronutrients, accumulation of dry mass and rate of forage accumulation, concentrations of crude protein, neutral detergent fiber, and acid detergent fiber, morphological components were evaluated. The data were subjected to analysis of variance using the Tukey test at the 5% significance level for the comparison of mean values. The use of foliar fertilizers, nitrogen fertilizer and biostimulant promoted accumulation of forage dry mass, leaf, stem and dead material and higher rates of accumulation of dry mass of stem and dead material of *Urochloa* hybrid Convert HD364.

**Key words:** chemical composition; forage; plant hormone; regulator; *Urochloa* hybrid Convert HD364.
**Abbreviations:** DM_dry mass; RA_rate of forage accumulation; CP_crude protein, NDF_neutral detergent fiber; ADF_acid detergent fiber; L:S_leaf:stem ratio.

**Introduction**

The pasture is the most important source of food for the production of cattle and milk and supplies up to 90% of their nutrition. In Brazil, the largest part of the pastureland is formed by monocultures, predominantly species of the genus *Urochloa*, due to its low requirement in soil fertility, tolerance to acidity and high productivity of dry mass (Gomes et al., 2015).
However, there is always a need to obtain new forage varieties adapted to different ecosystems. It is also a necessity for the Brazilian beef production. Genetic improvement allows production of species with wide adaptability to diverse climatic conditions, better productivity, resistance and digestibility. *Urochloa* hybrid Convert HD364 (Santos et al., 2015), resulted from the crossing of three generations: *Urochloa ruziziensis* x *Urochloa decumbens* cv. Basilik and intercrossing of the progenies with *Urochloa brizantha* cv. Marandu (Argel et al., 2007).
The potential production of a forage plant is determined genetically, but for this to be achieved we need suitable conditions of the environment and management. In tropical regions, the low availability of nutrients in the soil is one of the main factors. Application of nutrients in adequate quantities and proportions is a fundamental practice to increase production (Nogueira et al., 2015). That interferes with productivity and quality of forage. In Brazil, 70% of pastures are degraded or in advanced stages of degradation, reducing forage productivity by making the pastures unable to sustain the levels of production and the quality required by the animals. Inadequate practices of management, especially the high stocking rate of animals exceed the capacity of grazing recovery, trampling, the absence of regular fertilization, and flaws in the establishment of the pasture and biotic processes, such as the attack of pest insects, are aggravating factors in the process of degradation. Appropriate strategies for handling these practices should ensure a balance between the demand for forage and its ability to handle animal needs and the need to maintain the sustainability of the pasture (Santos et al., 2009).
The studies on the use of fertilizers for forage species are aimed at increasing the productivity of biomass for the development of vegetative structures of forage, such as shoots, leaves, among others (Catuchi et al., 2013). Despite the use of fertilizers for providing nutrients in the production system, their adoption by farmers in Brazil is still limited due to uncertainty to their bioeconomic performance in pastures and the variability observed in the responses of pasture and animals.
Techniques that improve the efficiency of fertilizers are increasingly being studied in agriculture. For example, foliar fertilizers are being periodically used as a supplement during

fertilization. Some of them have natural or synthetic biostimulants in their composition substances, which resemble phyto-hormones (Araújo et al., 2008).

Studies of interaction between biostimulants and foliar fertilizers in soybean showed increases in productivity (Vieira and Castro, 2001). Ávila et al. (2010) evaluated use of biostimulants associated with foliar fertilizers in beans and did not demonstrate improvement in performance.

The results of the research so far available are still conflicting, especially regarding the effect of biostimulants. Francis et al. (2016) conducted greenhouse and field trials in the period of 2011 to 2012 and concluded that the effect of chelated micronutrients and biostimulants may alter corn growth, but the productive responses are inconsistent and possibly related to environmental interactions. Similarly, Dourado-Neto et al. (2014) reported that the use of a biostimulant product composed of 0.5 g $L^{-1}$ of indole butyric acid, 0.9 g $L^{-1}$ quinetine and 0.5 g $L^{-1}$ of gibberellic acid in maize, provides an increase in diameter of corn stalk, number of grains per row, number of grains per spike, but does not interfere with crop yield. In the bean, the use of biostimulant in different doses and forms of application increased the number of grains per plant and grain yield.

The work carried out until now with the use of biostimulants involved the isolated use of these and were not associated with foliar fertilizers, and suggested further studies in this follow-up. Thus, the objective of this work was to evaluate the forage production, dry mass production, morphological components and nutritive value of pasture of *Urochloa* hybrid Convert HD364, with application of biostimulant, foliar fertilizers and urea.

## Results and Discussion

### Forage production in *Urochloa* hybrid Convert HD364

The production of total forage, leaves, stems and dead material and the rate of accumulation of total forage, leaves and stems differed among treatments ($p \leq 0.05$) (Table 1 and 3).

In the dry season, there were differences in the percentage of leaves and dead material ($p \leq 0.05$), while for the remaining variables for the percentage of stems and the ratio L:S, no differences were observed ($p \leq 0.05$) (Table 2). In the rainy season, we found no differences ($p \leq 0.05$) in the percentages of leaves, stems and dead material and the ratio L:S (leaves:stems) (Table 1).

In the rainy season, the T7 promoted a greater production of dead material ($p \leq 0.05$) compared to all the treatments. Application of T4, T6, and T7 treatments produced better results ($p \leq 0.05$) than the other treatments for production of dead material, leaves and stems (Table 1).

The production of dead material of *Urochloa* hybrid under T3, T4, T6 and T7 differed from the other treatments ($p \leq 0.05$). However, despite they increased the dead material, it is not considered adequate since dead material has a lower nutritional value (Table 1).

In the dry season, we found that all treatments differed from the T1 for the forage production, whereas the largest production was observed in T7 treatment. For the production of leaves, we found that treatments with biostimulant and foliar fertilizers (T4 and T3) produced more more leaves than T1 and T2. The treatments T6 and T7 promoted higher values that the T1, and the best results were for the treatment of T6 (Table 2).

The rate accumulation (RA) of forage and leaves in the dry season was better for the treatment T4, T6 and T7, in relation to the other treatments ($p \leq 0.05$). The treatments T4, T6 and T7 produced a higher RA of stem in relation to the other treatments ($p \leq 0.05$). The RA of dead material of T3, T4, T6 and T7 was higher compared to the other treatments ($p \leq 0.05$) (Table 1).

Among the functions of the biostimulants, the increase in the growth and development of plant tissue, stimulating cell division and elongation can be highlighted (Vieira and Castro, 2001). According to Moreira et al. (2016), the use of substances with biostimulant favors the performance of metabolic processes in plants, which corroborated with the present study, since the RA of forage, leaves and stems was not better in the treatment that used the isolated biostimulant in relation to the T1 ($p > 0.05$) (Table 1).

Nitrogen is one of the nutrients that promote a greater effect to the growth and development of the plant, to be part of the structure of the molecules of organic compounds such as amino acids, proteins and chlorophyll, and acts as an activator of enzymes in the implementation of vital processes such as photosynthesis and cellular respiration. This nutrient consequently increased the buildup of living material (leaves and stems) and reduced the accumulation of dead material in seed, corroborating with the results found in the present study. We demonstrated that all treatments containing urea promoted an increase in the percentage of accumulation of dead material in relation to the T1, and even promoted an increase in the percentage of production of *Urochloa* hybrid (Table 1).

From the data of percentage of leaf, stem and dead material we observed a close value in all treatments (Table 1). In contrast, in the dry season we found that biostimulant-only, treatment caused a greater percentage of leaves compared to T2. For the percentage of dead material, the Fertmicro showed a lower value than the treatment, in which the biostimulant was used (Table 2).

For a good development of forage species, it is necessary to have ideal conditions of temperature and precipitation. In January 2015, the average temperature was above 25°C and the average rainfall was below 200 mm, which may have affected the process of photosynthesis and evapotranspiration, and consequently made the plant processes, such as absorption and transport, less active, thus hindered the production of living material (leaves+stems). The lowest rainfall in the month of January may have provided a deleterious effect of lack of water and generated a lower production of forage mass. This influenced the final average of forage production of the period in which the present study was performed (Figure 1).

For the concentration of crude protein (CP) we observed a significant difference ($p \leq 0.05$). The treatment T4 promoted an improvement in the percentage of CP in relation to T1 and T7. There was no difference between the treatments on the concentrations of ADF and NDF ($p \leq 0.05$) for *Urochloa* hybrid. By analyzing the values of NDF, ADF and CP there was not observed any interference of any treatment in the dry season (Table 3).

In the present study, the ADF values ranged from 36.65 to 39.86%, 44% below the maximum value observed by Cândido et al. (2007). The ADF constitutes the indigestible part of the fiber in the bulk. However, the levels observed in the dry season were 49.67 to 54.35%, and were above this threshold (Table 3).

Reductions in ADF levels indicated an improvement in the nutritive value of silage, but in the dry season there was a water stress (Figure 1). The drought may have harmed the development of the forage, and consequently caused a negative correlation between the levels of ADF and food depletion. Negrão et al. 2016) reported that increase in ADF levels can cause reduction in the digestibility of pasture.

For the NDF during the rainy season, the average values were in the range between 67.88 to 71.10% and in the dry season between 78.33 to 83.67% (Table 3). This is a different result from Serafim (2012), in which for the management of pastures there was a desired percentage of NDF less than or equal to 65%, not reducing the DM intake by cattle, guaranteeing the ruminal microorganisms a greater utilization of nutrients in the diet.

The percentage of NDF in the rainy season of the present study corroborates with the results found in the literature, where to be within the range reported by Velásquez et al. (2010) for *Urochloa brizantha* cv. Marandu and Paciullo et al. (2009) for *Urochloa decumbens*. However, in the dry season, these values were greater than that found by these authors.

During the rainy season, application of Fertmicro reduced concentration of CP to be below 8%, which is considered a minimum value to meet the requirements of nitrogenous compounds from ruminal microorganisms and not compromising the use of the available energetic substrates (Lazzarini et al., 2009). In the dry season, all values were below this value (Table 3).

Argel et al. (2007) concluded that the content of CP for *Urochloa* hybrid is in the range of 8.0 to 16.0%, corroborating with the value observed in almost all treatments (Table 3).

The main constituent of the CP is N. However, no increase was not found on concentration of CP for the treatments urea (T2) as a source of N compared to the T1 (control). This is unlike the work of Benett et al. (2008), who found elevation in the levels of CP under doses of N. Protein is the second most nutritional component required by ruminants. Protein deficiency (below 7% CP in DM of the diet) causes reduction of consumption (Obeid et al., 2007), which was not observed in any treatment of this study.

The biostimulant acts in the absorption of nutrients, and because there was a high level of fertilization, the N was made available to the plant. The biostimulants assists in absorption of nutrition, especially N, facilitating their use by plant and promotes the improvement of CP content. This improvement was not observed in the treatments that used biostimulant associated with urea and/or foliar fertilizer.

No differences were observed between treatments (p>0.05), when the mean values of macro and micronutrients were compared (Table 4).

The foliar concentration suitable for P in the shoot is 0.8 to 3 g kg$^{-1}$ and K of 12 to 30 g kg$^{-1}$ (Perondi et al., 2007). In the present study, the two factors mentioned are in proper content (Table 4). In the rainy season, the foliar K absorbed by *Urochloa* was higher than that observed by Euclides et al. (1993) as 20.2 g kg$^{-1}$ in the year 1987/88; 18.8 g kg$^{-1}$ in 1988/89 and 1989/90 in 14.2 g kg$^{-1}$.

In all treatments, the leaf Ca, Mg and S contents were suitable for *Urochloa*, being 3 to 6 g kg$^{-1}$; from 1.5 to 4.0 g kg$^{-1}$ and 0.8 to 2.5 g kg$^{-1}$, respectively, in accordance with Perondi et al. (2007). The leaf content for Ca was similar to values found by Batista and Monteiro (2010) (3.0 to 6.0 g kg$^{-1}$). For the S, the mean values found in the treatments (Table 4) were higher than the content found by Ferrari Jr. et al. (1994), where authors found average values of 1.2 g kg$^{-1}$ in *Urochloa decumbens*.

According to Perondi et al. (2007), the leaf content suitable for B is between 10 to 25 mg kg$^{-1}$. In the present study, all treatments are in this range. The average value of Cu found in species of the genus *Urochloa* is 6.0 mg kg$^{-1}$ according to Carvalho et al. (2003). However, in the present study all treatments had values above these, ranging between 8.4 to 11.2 mg kg$^{-1}$ (Table 4).

According to Table 4, the leaf nutrient levels obtained in all treatments were at a minimum interval of 40 to 250 mg kg$^{-1}$ (Perondi et al., 2007). For Zn the obtained values found in the proper range was 20 to 50 mg kg$^{-1}$ (Perondi et al., 2007). Carvalho et al. (2003) found the average content of 24.6 mg kg$^{-1}$ for *Urochloa*. The foliar levels of Fe found on average in *Urochloa* are from 100 to 487 mg kg$^{-1}$ (Carvalho et al., 2003), corroborating with the values found in the present study (Table 4). Due to its toxicity, it is important to note that this nutrient is not in excess, especially by antagonistic interactions with P, in which the Fe absorption is decreased by the animal.

According to Table 5, for no nutrients (N, P, K, Ca, Mg, S, B, Cu, Fe, Mn, Zn) no difference was found (p>0.05) between the treatments.

Analysis of macronutrient accumulation showed that there was an accumulation order of K>N>Ca>P>Mg>S. The proportion found for N, P, K was 7.6; 1; 9.8, given that among the three of them, the K and N are the nutrients that plant accumulated more and P in smaller quantity, corroborating with the order found in the work of Braz et al. (2004). These authors also found that the Ca has accumulated more than P, corroborating with the results found here (Table 5).

It is important to note that the *Urochloa* hybrid was sown in soil with low P content (Table 1); thus, we are able to explain the low accumulation of this nutrient in the plant, since the Brazilian soils have low P content. This nutrient is determined by the fraction of clay, consisting mainly of Fe and Al oxides (Novais et al, 2008).

For the micronutrients we observed the following order of accumulation Fe>Mn>Zn>B>Cu (Table 5), corroborating with the order found in the work of Braz et al. (2004) and Oliveira et al. (2011) for *Urochloa*.

Application of biostimulants improves the absorption of nutrients in plants. However, Müller et al. (2016) concluded when the biostimulants are associated with foliar fertilizers they improve the absorption, utilization and accumulation of nutrients in plant. This disagrees with the results found in the present study, in which no treatment with the association of biostimulant and foliar fertilizers promoted the accumulation of nutrients (Table 4).

**Table 1.** Parameters of forage production at the time of the waters in *Urochloa* hybrid Convert HD364, subject to foliar application of Fertmicro, FertN and biostimulant.

| Treatment | PF | PL | PS | PDM |
|---|---|---|---|---|
| | ------------------------------kg ha$^{-1}$ of DM---------------------------- | | | |
| T1 | 6327.0 e | 5225.0 d | 1008.0 b | 93.6 b |
| T2 | 7148.0 d | 5970.0 c | 1090.0 b | 87.7 b |
| T3 | 7534.0 d | 6201.0 c | 1227.0 b | 105.6 a |
| T4 | 8630.0 bc | 7150.0 b | 1366.0 a | 113.7 a |
| T5 | 8364.0 c | 7020.0 b | 1261.0 b | 84.0 b |
| T6 | 9125.0 ab | 7645.0 a | 1371.0 a | 109.0 a |
| T7 | 9595.0 a | 7890.0 a | 1580.0 a | 125.5 a |
| CV(%) | 3.60* | 4.77* | 9.30* | 14.00* |
| Treatment | Leaves | Stems | Dead material | L:S |
| | -------------------------%--------------------------- | | | |
| T1 | 82.47 a | 16.01 a | 1.51 a | 5.25 a |
| T2 | 83.52 a | 15.25 a | 1.23 a | 5.49 a |
| T3 | 82.30 a | 16.30 a | 1.40 a | 5.08 a |
| T4 | 82.84 a | 15.85 a | 1.32 a | 5.26 a |
| T5 | 83.92 a | 15.07 a | 1.00 a | 5.62 a |
| T6 | 83.77 a | 15.04 a | 1.20 a | 5.59 a |
| T7 | 82.25 a | 16.44 a | 1.31 a | 5.05 a |
| CV (%) | 1.93 | 9.32 | 17.15 | 11.41 |
| Treatment | RAF | RAL | RAS | |
| | -------------------------kg ha$^{-1}$ day$^{-1}$ of DM------------------------ | | | |
| T1 | 46.5e | 33.1d | 6.4b | |
| T2 | 51.5d | 37.8c | 6.9b | |
| T3 | 55.1d | 39.25c | 7.8b | |
| T4 | 62.7c | 45.25b | 8.6a | |
| T5 | 59.1c | 44.4b | 8.0b | |
| T6 | 65.5b | 48.4a | 8.7a | |
| T7 | 69.7a | 49.9a | 10.0a | |
| CV(%) | 3.60* | 4.80* | 9.30* | |

T1 (control (no fertilization)), T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant); PF: production of DM; PL: production of leaves; PS: production of stems; PDM: production of dead material; RAF: rate of forage accumulation; RAL: rate of accumulation of leaves; RAS: rate of accumulation of stems; RADM: The rate of accumulation of dead material; L:S: leaf:stem ratio; CV: Coefficient of variation. Average followed by letters equal in column do not differ by Tukey test at 0.05. *: q ≤ 0.05 significant differences.

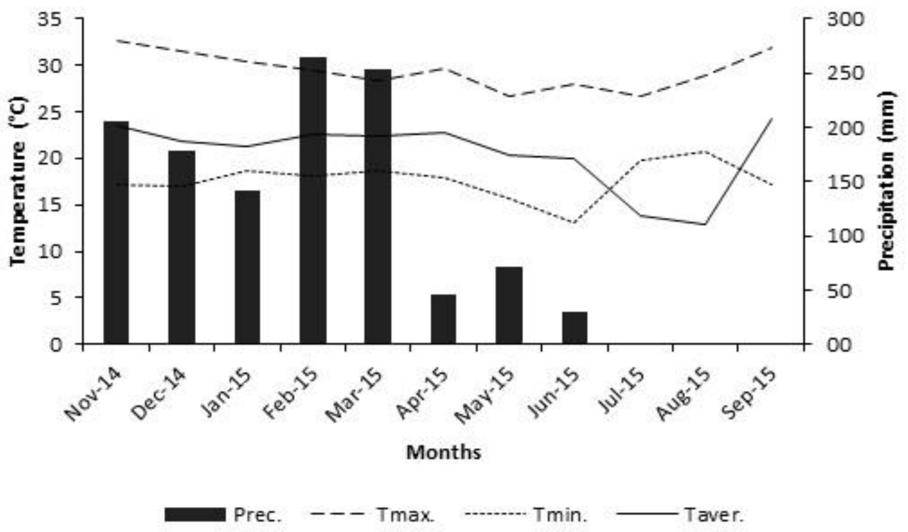


**Fig 1.** Maximum temperature, minimum temperature and average temperature and precipitation in the experimental area of *Urochloa* hybrid at the time of rainy (November to March) and dry season (April to September).

**Table 2.** Parameters for forage production in the dry season in *Urochloa* hybrid Convert HD364, subject to foliar application of Fertmicro, FertN and biostimulant.

| Treatment | PF | PL | PS | PDM |
|---|---|---|---|---|
| | ------------------------kg ha$^{-1}$ of DM------------------------ | | | |
| T1 | 845.0 g | 247.0 c | 4430.0 c | 155.0 b |
| T2 | 985.0 f | 268.0 c | 515.0 c | 203.0 b |
| T3 | 1111.0 e | 366.0 b | 554.0 bc | 191.0 b |
| T4 | 1297.0 d | 393.0 b | 591.0 bc | 314.0 b |
| T5 | 1201.0 c | 438.0 b | 560.0 bc | 204.0 a |
| T6 | 1414.0 b | 410.0 b | 741.0 a | 262.0 a |
| T7 | 1517.0 a | 529.0 a | 692.0 ab | 297.0 a |
| CV(%) | 4.00* | 13.10* | 13.40* | 13.10* |
| Treatment | Leaves | Stems | Dead material | L:S |
| | -------------------------%--------------------------- | | | |
| T1 | 29.35 ab | 52.01 a | 18.62ab | 0.58 a |
| T2 | 27.26 b | 52.23 a | 20.51ab | 0.53 a |
| T3 | 32.93 ab | 49.86 a | 17.20b | 0.66 a |
| T4 | 30.41 ab | 45.46 a | 24.12 a | 0.68a |
| T5 | 36.44 a | 46.59 a | 16.96b | 0.79 a |
| T6 | 29.23 ab | 52.20 a | 18.56ab | 0.58 a |
| T7 | 34.82 ab | 45.60 a | 19.60ab | 0.78 a |
| CV (%) | 13.95* | 10.87 | 14.91* | 11.57 |
| Treatment | RAF | RAL | RAS | |
| | -------------------------kg ha$^{-1}$ day$^{-1}$ of DM--------------------- | | | |
| T1 | 6.65 g | 1.95 c | 3.50 c | |
| T2 | 7.75 f | 2.10 c | 4.05 c | |
| T3 | 8.75 e | 2.90 b | 4.36 bc | |
| T4 | 10.20 c | 3.09 b | 4.65 bc | |
| T5 | 9.45 d | 3.45 b | 4.41 bc | |
| T6 | 11.15 b | 3.23 b | 5.83 a | |
| T7 | 12.00 a | 4.16 a | 5.45 ab | |
| CV(%) | 4.00* | 13.05* | 13.42* | |

T1 (control (no fertilization)), T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant); PF: production of DM; PL: production of leaves; PS: production of stems; PDM: production of dead material; RAF: rate of forage accumulation; RAL: rate of accumulation of leaves; RAS: rate of accumulation of stems; RADM: The rate of accumulation of dead material; L:S: leaf:stem ratio; CV: Coefficient of variation. Average followed by letters equal in column do not differ by Tukey test at 0.05. *: q ≤ 0.05 significant differences.

**Table 3.** Parameters of nutritive value of the forage harvester in *Urochloa* hybrid, subject to foliar application of Fertmicro, FertN and biostimulant.

| Treatment | Water | | | Dry season | | |
|---|---|---|---|---|---|---|
| | NDF | ADF | CP | NDF | ADF | CP |
| | ---------------------------------------%--------------------------------------- | | | | | |
| T1 | 70.93 a | 39.86 a | 7.98 b | 81.40 a | 54.16 a | 4.26 a |
| T2 | 71.10 a | 39.81 a | 8.57 ab | 80.21 a | 49.67 a | 4.17 a |
| T3 | 68.94 a | 39.85 a | 7.94 b | 83.67 a | 51.32 a | 4.19 a |
| T4 | 67.88 a | 39.00 a | 9.82 a | 78.73 a | 53.88 a | 4.19 a |
| T5 | 69.74 a | 38.48 a | 8.65 ab | 82.63 a | 52.83 a | 4.25 a |
| T6 | 68.73 a | 36.65 a | 8.67 ab | 83.31 a | 54.35 a | 4.25 a |
| T7 | 68.67 a | 39.38 a | 8.24 b | 80.77 a | 53.02 a | 4.12 a |
| CV(%) | 3.12 | 4.82 | 8.85* | 5.45 | 8.2 | 14.22 |

T1 (control (no fertilization)), T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant); NDF: Neutral detergent fiber; ADF: acid detergent fiber; CP: Crude protein; CV: Coefficient of variation. Average followed by letters equal in column do not differ by Tukey test at 0.05. * significant differences

**Table 4.** Levels of macro and micronutrients foliar *Urochloa* hybrid in function of different treatments at the time of rainy season.

| Treatment | ---------------------------- g kg$^{-1}$ ----------------------- | | | | | |
|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | S |
| T1 | 21.5 a | 3.2 a | 28.1 a | 4.4 a | 2.8 a | 1.8 a |
| T2 | 23.0 a | 2.6 a | 29.4 a | 4.6 a | 2.7 a | 1.7 a |
| T3 | 22.3 a | 2.7 a | 28.4 a | 4.7 a | 2.8 a | 1.7 a |
| T4 | 23.7 a | 2.9 a | 28.6 a | 4.6 a | 3.0 a | 1.8 a |
| T5 | 25.3 a | 3.3 a | 30.6 a | 4.6 a | 3.1 a | 1.9 a |
| T6 | 20.7 a | 3.1 a | 30.4 a | 4.5 a | 2.9 a | 1.7 a |
| T7 | 21.6 a | 3.2 a | 29.5 a | 4.7 a | 2.9 a | 1.8 a |
| CV(%) | 8.58 | 16.89 | 11.63 | 8.79 | 10.66 | 10.76 |
| Treatment | ---------------------------- mg kg$^{-1}$ ----------------------- | | | | | |
| | B | Cu | Fe | Mn | | Zn |
| T1 | 11.7 a | 8.4 a | 345.6 a | 120.9 a | | 24.1 a |
| T2 | 10.0 a | 9.2 a | 316.3 a | 143.4 a | | 28.8 a |
| T3 | 11.8 a | 9.0 a | 307.9 a | 147.1 a | | 24.6 a |
| T4 | 11.8 a | 9.1 a | 397.7 a | 148.1 a | | 31.6 a |
| T5 | 12.0 a | 9.1 a | 460.1 a | 167.0 a | | 34.2 a |
| T6 | 11.0 a | 11.2 a | 397.0 a | 155.5 a | | 25.9 a |
| T7 | 10.2 a | 8.6 a | 285.3 a | 145.7 a | | 29.7 a |
| CV(%) | 17.18 | 29.23 | 19.07 | 14.24 | | 22.14 |

T1 (control (no fertilization)), T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant); Average followed by letters equal in column do not differ by Tukey test at 0.05; CV: Coefficient of variation.

**Table 5.** Accumulation of macro and micronutrients in leaves of *Urochloa* hybrid in function of different treatments at the time of rainy season.

| Treatment | ---------------------------- kg ha$^{-1}$ ------------------------ | | | | | |
|---|---|---|---|---|---|---|
| | N | P | K | Ca | Mg | S |
| T1 | 142.9 a | 21.7 a | 188.6 a | 29.1 a | 18.6 a | 12.0 a |
| T2 | 159.8 a | 18.0 a | 204.8 a | 32.3 a | 18.5 a | 12.1 a |
| T3 | 146.3 a | 21.5 a | 225.0 a | 37.3 a | 22.1 a | 13.5 a |
| T4 | 164.8 a | 20.0 a | 200.4 a | 32.3 a | 21.0 a | 12.6 a |
| T5 | 178.9 a | 23.2 a | 217.2 a | 32.8 a | 21.7 a | 13.7 a |
| T6 | 176.9 a | 22.2 a | 215.3 a | 31.3 a | 20.2 a | 12.3 a |
| T7 | 152.3 a | 21.9 a | 203.9 a | 33.3 a | 20.0 a | 12.7 a |
| CV (%) | 17.11 | 20.04 | 18.65 | 19.82 | 16.40 | 17.28 |
| Treatment | ---------------------------- g ha$^{-1}$ ------------------------ | | | | | |
| | B | Cu | Fe | Mn | Zn | |
| T1 | 77.3a | 56.2a | 2325.0a | 805.3a | 161.6a | |
| T2 | 70.1a | 64.9a | 2255.4a | 997.7a | 202.5a | |
| T3 | 93.0a | 71.6a | 2448.4a | 1169.1a | 195.0a | |
| T4 | 81.4a | 64.4a | 2791.7a | 1027.5a | 221.3a | |
| T5 | 86.7a | 64.9a | 3217.9a | 1174.6a | 240.1a | |
| T6 | 76.8a | 76.7a | 2791.9a | 1098.5a | 182.7a | |
| T7 | 74.6a | 60.6a | 2002.7a | 1019.2a | 202.0a | |
| CV (%) | 23.65 | 30.80 | 1864.46 | 19.85 | 23.84 | |

T1 (control (no fertilization)), T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant); Average followed by letters equal in column do not differ by Tukey test at 0.05.

**Table 6.** Chemical characterization of soil in the experimental area of *Urochloa* hybrid.

| Prof. | pH | P | K | Ca | Mg | Al | MO | SB | T | V |
|---|---|---|---|---|---|---|---|---|---|---|
| Cm | $H_2O$ | ------mg dm$^{-3}$------ | | ---------cmol$_c$ dm$^{-3}$--------- | | | ----dag kg$^{-1}$--- | ---------%---------- | | |
| 0 – 20 | 5.5 | 1.6 | 118.0 | 2.0 | 0.9 | 0.0 | 3.8 | 3.2 | 7.9 | 40.0 |

P=Method Mehlich1, P, K, Na = [HCl 0.05 mol L$^{-1}$ + $H_2SO_4$ 0.0125 mol L$^{-1}$], S-$SO_4$ = Monobácico Calcium Phosphate [0.01 mol L$^{-1}$], Ca, Mg, Al = [KCL 1 mol L$^{-1}$], MO = Colorimetric Method, SB= Sum of base, V = Base saturation; T = CEC at pH 7.0.

**Materials and Methods**

***Description of the environment***

The experiment was conducted in the experimental area of the nucleus of forage in the Capim Branco Farm, belonging to the Federal University of Uberlândia, in the city of Uberlândia, Minas Gerais, located at coordinates 18°52’55’66 S and 48°20’28’21 W, at an altitude of 805m, between the period from November 2014 (rainy) to September 2015 (dry).

The climate of the region is classified as Aw by the method of Köppen, tropical, hot and humid climate, with cold and dry winter. The average annual rainfall is 1606 mm and the average annual temperature is 21.5°C with 1479 mm average annual rainfall (Rolim et al., 2007). The climatic data was collected from station in the Capim Branco Farm, during the period of conduction of the experiment. The precipitation and the average temperature are shown in Figure 1.

The experiment was carried out in areas of Red-Yellow Latosol (Oxisol), according to the Brazilian System of Soil Classification (V> 50%) (Santos et al., 2013). Prior to the installation of the experiment, the soil was collected and the chemical analysis was carried out for the purpose of ascertaining the fertility. The results of chemical analysis of the soil are shown in Table 6.

***Description of treatments and statistical design***

In November 2013, the *Urochloa* hybrid was sown in the experimental area. We established the plots in 4m x 4m, totally 21 plots. The conduction of the experiment began on November 22, 2014 and ended on September 30, 2015. We called November to March as water period (rainy) and months from April to September as dry season.

The biostimulant that used in study contained synthetic substances with actions similar to the plant hormones such as gibberellin, cytokinin and auxin, and the foliar fertilizers based on Nitrogen (N), Sulfur (S), Boron (B), Copper (Cu), Manganese (Mn) and Zinc (Zn) and micronutrient base, named as FERTN and FERTMICRO, respectively.

The experimental design was a completely randomized design, with seven treatments and three replications. The treatments were: T1 control: no fertilization, T2 (urea), T3 (Fertmicro), T4 (FertN), T5 (biostimulant), T6 (Fertmicro+biostimulant), T7 (FertN+biostimulant).

The treatments consisted of foliar fertilizers, associated or not with biostimulant, with the addition of vegetable oil Natur’lOléo®, with adjuvant action and at concentration of 0.5% solution.

For the cutting of forage, the methodology of Dim et al. (2015) was used. The cut was done in total area after sampling of four random experimental plots that had average values for plant height exceeding 30 cm.

The first foliar application of the solution was made after the standardization cut on November 26, 2014. Subsequently, three more applications with intervals of 18, 36 and 40 days were done. It was conducted with a pressurized $CO_2$ backpack sprayer, equipped with 2 meters and 4 nozzles type range, to implement only the treatments that have foliar fertilizers and/or biostimulant. A spray volume of 200 L ha$^{-1}$ was applied.

***Parameters evaluated***

The parameters such as leaf content and accumulation of macro and micronutrients, accumulation of DM (dry mass) and RA (rate of forage accumulation), CP (concentrations of crude protein), NDF (neutral detergent fiber), ADF (acid detergent fiber), morphological components (percentage, accumulation of dry mass (DM) of leaves, stem and dead material and RA of leaves and stem and leaf:stem (L:S) ratio (F:C) were evaluated. The forage mass and leaf reference were collected earlier to the cuts made in total area, homogenizing and separating the materials at the end of the experiment.

The last fully expanded leaf per unit of plant was collected randomly, called reference sheet, totaling 30 units per plot. The samples were placed in paper bags and taken to a forced air circulation oven at a temperature of 65°C for 72 hours. After drying, the samples were passed through the milling process in Willey type mill (2mm). Then, they were transferred to the laboratory which performed the analysis of the levels of macro and micronutrients.

The methods used for the determination of the leaf macro and micronutrients were: sulfuric acid digestion of N (Total N), nitro perchloric digestion for phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), copper (Cu), iron (Fe), manganese (Mn), zinc (Zn) and boron incineration (B) (Malavolta, 2006). For accumulation of macro and micronutrients in the forage, we multiplied the leaf content of each nutrient accumulation of DM of sheets in kg $ha^{-1}$.

***Analyses of accumulation of DM and RA in forage***

Concentrations of CP, NDF, ADF, accumulation and percentage of DM of leaves, stem and dead material and RA of leaves and stem and relation L:S, were made on herbage mass of *Urochloa* hybrid in each plot at two areas with the aid of a metal bracket (1.00 x 0.50m). It was launched randomly with the cut made to 15 cm from the ground level using gardening scissors. The sample from each plot was homogenized, separated into three subsamples and placed in identified plastic bags.

For the determination of forage accumulation of DM, each subsample was first weighed to get the production of green mass, then taken to a forced air circulation oven at a temperature of 65°C for a period of 72 hours, to measure dry mass (DM). By means of the green mass and dry mass ratio, the percentage of dry mass (DM %) was calculated in kg $ha^{-1}$ of *Urochloa* hybrid.

After determining the accumulation of dry mass of forage, the subsample was initially ground in a Willey type mill (2mm). Then, the subsamples were stored in plastic bags for analyses of concentrations of CP, NDF and ADF in the laboratory.

The determinations were performed for total nitrogen according to Kjeldahl balances method (Nogueira and Souza, 2005). From the values of total N, the content of CP was estimated multiplying by the conversion factor of 6.25 (Campos et al., 2004).

The determination of lignin content is performed from the concentration of ADF, as described by Silva and Queiroz (2002) and the assessment of concentrations of NDF followed the protocols suggested by Mertens (2002).

For the evaluations of the morphological composition, the material was fractionated, with the aid of scissors, in sheets (green leaves), stems (stems and leaf sheaths) and dead material. After the separation, each fraction was placed in a paper bag, weighed and brought to a forced air circulation oven at a temperature of 65°C for a period of 72 hours. Then, they were weighed again. The data weights were used to calculate the percentage of dry weight of each morphological component in relation to the total dry mass of the subsample.

From the percentage of each component, we calculated the accumulation of dry mass of leaves, stems and dead material per hectare.

Accumulation of dry mass of the component was calculated as: % of Component x accumulation of forage dry mass in kg $ha^{-1}$.

For the calculation of relation L:S we divided the percentage of leaves by the percentage of stalk.

The RA was calculated by the accumulation of forage dry mass, accumulation of total dry mass of each morphological component (leaf and stem) divided by the total number of days in the water period and drought.

The results were first subjected to tests of presuppositions, homogeneity, heterogeneity and additivity to evaluate the normality of the waste and the homogeneity of the variances, respectively. After that, the data were subjected to analysis of variance. For the assessment of the effects of treatments, we used Tukey test at 5% significance level.

**Conclusion**

The use of foliar fertilizers containing N and micronutrients associated or not with biostimulant promoted accumulation of forage dry mass, leaf, stem and dead material, higher rates of accumulation of dry mass of stem and dead material of *Urochloa* hybrid Convert HD364 in times of rainy and drought seasons. The foliar fertilizer with the base of N associated with biostimulant improved the content of crude protein of *Urochloa* hybrid Convert HD364 at the time of rainy season.

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