

4 **Agronomic characteristics and chemical-**
5 **bromatological composition of piatã grass**
6 **submitted to nitrogen doses and cutting**
7 **heights**
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12 **ABSTRACT**
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This study aimed to evaluate the chemical-bromatological composition of the piatã grass submitted to different cutting heights and nitrogen (N) doses. A completely randomized design with sixteen treatments and four replications was used. The treatments were arranged in 4x4 factorial arrangement, being four cutting heights (8, 16, 24 and 32 cm) and four nitrogen doses (0, 100, 200, 300 kg ha⁻¹ of N). The N doses were applied after the standardization and after the first cut, evaluating two cuts. For agronomic characteristics, the number of tillers, dry mass, leaf blade pseudocolus-1 ratio and amount of senescent material were determined. In the chemical-bromatological composition, crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and mineral matter (MM) were analyzed for the morphological components leaf blade and pseudostem. In addition to quantifying the dry matter of both components. It was concluded that cutting heights of 16 and 24 cm combined with doses of 200 to 300 kg ha⁻¹ of N contributed to the improvement of agronomic characteristics and chemical-bromatological, and therefore, productive efficiency in pasture systems.

15
16 *Keywords: fertilization; management; piatã grass; tillering.*
17

18 **1. INTRODUCTION**
19

20 Cattle production in Brazil has native and cultivated pastures as the main source of food,
21 due to the large extension of available areas and the great adaptability of the plants currently
22 cultivated. With grazing livestock production, it is possible to produce quality meat at a
23 reduced cost [1].

24 Studies indicate that between 50% and 70% of the pastures present some degree of
25 degradation, mainly due to inadequate management and lack of cultural treatments such as
26 soil fertilization [2]. The low soil fertility associated with the absence or inefficiency of
27 maintenance fertilizers, especially nitrogen fertilization, triggers the process of degradation of
28 pastures, which today represents one of the biggest problems of Brazilian livestock farming
29 [3].

30 Nitrogen (N) is the most influencing in terms of gains in forage production. Its application is
31 of crucial relevance for the maintenance of the productivity and the sustainability of the
32 pasture. In maintenance manures, it is required in larger quantities, and its cycle in the

33 ecosystem is of paramount importance to avoid degradation of pastures [4]. It is the main
34 constituent of the proteins that actively participate in the synthesis of the organic compounds
35 that form the structure of the plant. In this way, it is responsible for the structural
36 characteristics of the plant (leaf size, tiller density and leaves per tiller), as well as
37 morphogenic characteristics foliar growth rate and foliar senescence [5], is also able to alter
38 the proportion of these morphological components, being the richest and most easily
39 digestible leaves [6].

40 In a grazing cattle system, several factors interact with each other. The understanding of the
41 functioning of these factors and, therefore, of the causal relations that govern their behavior
42 passes through the knowledge of its components and of its degree of organization [7].

43 The principle of any bovine production system is to achieve a balance between food demand
44 and supply (energy and digestible/metabolizable nutrients). Theoretically, fodder considered
45 of high quality should be able to provide the necessary nutrients to meet the requirements of
46 grazing animals. Dry matter (DM) intake is the most important factor in nutrition, since it
47 establishes the amount of nutrients available for health and animal production [8].

48 The idealization and formulation of pasture management strategies based on pasture goals,
49 particularly height, become a real alternative and basic premise for improving and increasing
50 the efficiency and production of animal production systems in tropical pastures [9].

51 The proportion of leaves in the forage produced and the leaf/stem ratio has been used as
52 reference in pasture management, since they influence the ingestive behavior and the
53 performance of ruminants in grazing. The highest leaf/stem ratio can be used as an index of
54 forage nutritive value, as well as the height of the pasture and the availability of dry matter,
55 which facilitates the forage apprehension by the animal and thus its behavior during grazing
56 [10; 11].

57 The objective of this study was to evaluate the agronomic characteristics and the chemical-
58 bromatological composition of the piatã grass (*Brachiaria* (syn. *Urochloa*) *brizantha* cv. BRS
59 Piatã) submitted to different cutting heights and nitrogen doses.

60

61 **2. MATERIAL AND METHODS**

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63 The experiment was carried out in a greenhouse of the Faculty of Agronomy and Animal
64 Science at the Federal University of MatoGrosso (UFMT, *Universidade Federal de*
65 *MatoGrosso*) using the piatã grass (*B.brizantha* cv. BRS Piatã). During the experiment, the
66 temperature was monitored (minimum of 25°C, maximum of 41°C).

67 The soil used in the experiment was collected in the municipality of Santo Antonio do
68 Leverger – MT, Brazil, in an area belonging to the Experimental Farm of the Federal
69 University of MatoGrosso, sheep department, at depth of 0 to 20 cm. In previous years, the
70 area where the soil was collected was cultivated with maize for silage production in the same
71 area. After the collection, the soil was dried, sifted, homogenized and placed in plastic pots
72 with a capacity of 8 kg, using 6.5 kg of soil in each pot. The soil was classified as Yellow
73 Latosol [12].

74 Sowing was performed on November 1, 2007, using 30 seeds per pot. Seedling emergence
75 occurred seven days after sowing. Periodic thinning was performed until six plants remained
76 per pot. Regarding the water requirement, the vessels were maintained in the field capacity,
77 being monitored three times a day.

78 At the last thinning, 40 days after sowing, the four nitrogen doses were applied. At that
79 moment, the standardization cut was also performed at the pre-determined height, being
80 measured with a graduated ruler from the ground level.

81 The treatments were arranged in 4x4 factorial arrangement, being four nitrogen doses (N)
82 and four cutting heights. As for N, nitrogen doses equivalent to 0, 100, 200 and 300 kg ha⁻¹
83 of N (0, 0.72, 1.44 and 2.16 g pot⁻¹) were applied, using as fertilizer the urea. Always before
84 the application of N, cuts were made at the previously defined heights of 8, 16, 24 and 32
85 cm. The first application was performed after the standardization cut. After 30 days the first
86 cut and the second application of the nitrogen fertilization to the new growth cycle were
87 performed. The experimental design was a completely randomized design with 16
88 treatments and 4 replications.

89 Two harvests were made, the forage being separated in the botanical components of aerial
90 part: leaf blade, stem + sheath (pseudocolus) and senescent material. Subsequently, all the
91 material was dried to constant weight in an oven at 60 °C for 72 hours. After pre-drying, the
92 samples were weighed and milled in a Willey mill with 2-mesh sieve. The ground material
93 was then packed in plastic bags for further chemical analysis.

94 As for the agronomic characteristics, the number of tillers, dry mass (g pot⁻¹), leaf-blade /
95 pseudocolus ratio and senescent material production (g pot⁻¹) were evaluated. It is worth
96 mentioning that the evaluation of tillering was done by counting the number of tillers per
97 pots, performed before each cut.

98 The determination of the dry matter content of the leaf blade, pseudocolus and senescent
99 material components of the samples was performed according to the authors cited in the
100 reference [13].

101 The crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (FAD) and
102 mineral matter (MM) were determined according to the methodology of the authors cited in
103 the reference [13].

104 The data were submitted to analysis of variance and regression, using the SANEST software
105 [14].

106 3. RESULTS AND DISCUSSION

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108 In the first cut, the highest number of tillers (21 tiller pot⁻¹) was observed at 24 cm height,
109 combined with the dose of 207.75 kg ha⁻¹ N (Table 1).

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112

113 Table 1. Agronomic characteristics and production of *piatã* grass submitted to N doses and
114 cutting heights.

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Cutting height (cm)	N Dose (kg ha ⁻¹)				Adjusted Equation	R ²
	0	100	200	300		
	Tiller number (n°pot ⁻¹)					
8	15.425	17.255	17.025	14.825	$y = 15.425 + 0.028x - 0.0001x^2$	0.99

16	12.675	18.025	18.975	15.525	$y = 12.675 + 0.0755x - 0.0002x^2$	0.99
24	11.938	18.248	20.558	18.868	$y = 11.938 + 0.0831x - 0.0002x^2$	0.99
32	13.75	17.87	17.99	14.11	$y = 13.75 + 0.0612x - 0.0002x^2$	0.99
DM Production (g pot ⁻¹)						
1 st Cut						
8	3.1775	5.1975	5.2175	3.2375	$y = 3.1775 + 0.0302x - 0.0001x^2$	0.98
16	4.8231	7.4331	8.0431	6.6531	$y = 4.8231 + 0.0361x - 0.0001x^2$	0.99
24	2.8398	5.9398	7.4398	7.3398	$y = 2.8398 + 0.039x - 0.00008x^2$	0.94
32	2.1361	4.9461	6.1561	5.7661	$y = 2.1361 + 0.0361x - 0.00008x^2$	0.99
2 nd Cut						
8	2.1769	4.6069	5.0369	3.4669	$y = 2.1769 + 0.0343x - 0.0001x^2$	0.80
16	2.5561	8.0261	9.4961	6.9661	$y = 2.5561 + 0.0747x - 0.0002x^2$	0.99
24	2.3408	8.8908	11.4408	9.9908	$y = 2.3408 + 0.0855x - 0.0002x^2$	0.92
32	1.9971	9.2171	12.4371	11.6571	$y = 1.9971 + 0.0922x - 0.0002x^2$	0.98
Leaf blade/pseudocolus ratio						
1 st Cut	2.0971	2.2271	3.5471	6.8671	$y = 2.9071 - 0.0168x + 0.0001x^2$	0.99
2 nd Cut						
8	1.5574	3.2174	3.4774	2.3374	$y = 1.5574 + 0.0236x - 0.00007x^2$	0.75
16	2.0105	5.8205	7.2905	6.4205	$y = 2.0105 + 0.0498x - 0.000117x^2$	0.99
24	2.0569	6.8769	9.0969	8.7169	$y = 2.0569 + 0.0612x - 0.00013x^2$	0.93
32	1.7544	7.4324	10.0064	9.4764	$y = 1.7544 + 0.0723x - 0.0001552x^2$	0.98
Senescent Material Production (g pot ⁻¹)						
1 st Cut						
24	2.0569	6.8769	9.0969	8.7169	$y = 2.0569 + 0.0612x - 0.00013x^2$	0.93
32	1.7544	7.4324	10.0064	9.4764	$y = 1.7544 + 0.0723x - 0.0001552x^2$	0.98
2 nd Cut						
24	0.3426	0.6726	0.6026	0.1326	$y = 0.3426 + 0.0053x - 0.00002x^2$	0.58
32	0.4093	1.1793	1.1493	0.3193	$y = 0.4093 + 0.0117x - 0.00004x^2$	0.92

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117 Similar results in the response to nitrogen fertilization were reported by the authors
 118 referenced [15], in which the maximum tillering in the establishment of *brachiariadecumbens*
 119 (*B. decumbens*) and marandu grass (*B. brizantha* cv. Marandu) occurred, respectively, in the
 120 183 and 178 mg dm⁻³. In addition, the authors cited in the reference [16] quantified the
 121 maximum number of tillers in the marandu grass at the nitrogen dose of 188 mg dm⁻³, being
 122 this increase attributed to the influence of nitrogen on the structural characteristics of forage
 123 [17].

124 In the first cut, maximum yield (8.08 g pot⁻¹) at the height of 16 cm was observed, combined
 125 with the intermediate dose of 180.50 kg ha⁻¹ of N (Table 1). In the second cut (Table 1) the
 126 maximum yield (12.62 g pot⁻¹) was obtained at the height of 32 cm combined with the dose

127 of 230.50 kg ha⁻¹ of N. The authors cited in the references [18] with Xaraés grass (*B.*
 128 *brizantha* cv. Xaraés), verified that there was an increase in the total dry mass production of
 129 the aerial part, due to the increase in the production of leaves under increasing doses of N.

130 For the leaf blade/pseudocolus ratio, only the effect of N doses occurred in the first cut
 131 (Table 1), and doses from 84 kg ha⁻¹ of N provided an increase in the leaf
 132 blade/pseudocolus ratio. In the second cut, the highest leaf-blade/pseudocolus ratio (10, 17)
 133 was verified at the height of 32 cm and at the dose of 232.92 kg ha⁻¹ of N (Table 1). The
 134 authors mentioned in the references [18] performing correction of nitrogen and potassium
 135 doses, verified that in the highest N doses, the leaf blade/pseudocolus ratio decreased in the
 136 Xaraés grass (*B. brizantha* cv. Xaraés), due to the higher plant growth and to the elongation
 137 process of the stems.

138 In the first cut, there was no effect of cutting heights or nitrogen doses on the production of
 139 senescent material, being associated with the fact that the plant is in its first growth cycle,
 140 having a large proportion of young tissue in its botanical composition. In the second cut at
 141 the height of 32 cm, the highest production of senescent material (1.26 g pot⁻¹) at the 146.25
 142 kg ha⁻¹ dose of N was observed (Table 1).

143 Comparing with studies by the authors cited in the references [19] with Marandu grass the
 144 leaf senescence rate was also higher in pastures maintained at greater heights. One
 145 measure that can prevent forage loss through senescence is to adjust grazing management,
 146 that is, when there is an increase in N doses (fertilization), it is necessary to increase also
 147 the intensity of cut or defoliation.

148 In addition, it was verified that the higher nitrogen dose (300 kg ha⁻¹ of N) provided a
 149 reduction in the senescent material production (in both cutting heights of 24 and 32 cm). A
 150 benefit also reported by the authors cited in references [20] in studies with Tanzania grass
 151 pastures (*Panicum maximum* Jacq. cv. Tanzania-1), being associated with light intercepted
 152 by the leaf surface.

153 There was no interaction between the N doses and the cutting heights, but there was effect
 154 of the nitrogen doses on the CP content in the leaf blades in the first cut. There was an
 155 increase of 0.0139% and 0.008% in the CP content per kg of N applied in the piatã grass
 156 (Table 2), in the first and second cut, respectively.

157 At 300 kg ha⁻¹ of N, the highest CP content (9.06%) was observed in the first cut compared
 158 to the second one (7.43%), possibly due to the fact that in the first cut tissues were tenderest
 159 and younger, since the plants were in the first growth cycle (Table 2).

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Table 2. Chemical-bromatological composition of the piatã grass submitted to N doses and cutting heights.

Cutting height (cm)	N Dose (kg ha ⁻¹)				Adjusted Equation	R ²
	0	100	200	300		
Leaf blade CP content(%)						
1 st Cut	4.8898	3.4998	2.1098	0.7198	y = 4.8898 - 0.0139x	0.99
2 nd Cut	5.0301	5.8301	6.6301	7,4301	y = 5.0301 + 0.008x	0.98

Pseudocolus CP content (%)						
1 st Cut						
8	2.8886	5.5686	6.6486	6.1286	$y = 2.8886 + 0.0348x - 0.00008x^2$	0.94
16	2.6329	4.9529	6.0729	5.9929	$y = 2.6329 + 0.0292x - 0.00006x^2$	0.97
24	2.766	3.8445	4.923	6.0015	$y = 2.766 + 0.010785x$	0.92
32	6.3839	4.8829	4.5399	5.3549	$y = 6.3839 - 0.0208x + 0.0000579x^2$	0.95
2 nd Cut	3.7563	4.3363	4.9163	5.4963	$y = 3.7563 + 0.0058x$	0.81
Leaf blade NDF (%)						
1 st Cut	80.964	73.064	69.434	69.804	$y = 80.694 - 0.0963x + 0.0002x^2$	0.99
2 nd Cut	78.712	72.412	70.112	71.812	$y = 78.712 - 0.083x + 0.0002x^2$	0.94
Pseudocolus NDF (%)						
1 st Cut						
8	87.673	84.073	80.473	76.873	$y = 87.673 - 0.036x$	0.93
16	86.6791	81.7511	79.5071	78.9471	$y = 86.6791 - 0.0627x + 0.0001342x^2$	0.98
24	85.133	82.823	80.513	78.203	$y = 85.133 - 0.0231x$	0.99
32	85.001	83.011	81.021	79.031	$y = 85.001 - 0.0199x$	0.95
2 nd Cut	80.402	85.342	84.282	77.222	$y = 80.402 + 0.0794x - 0.0003x^2$	0.94
Leaf blade ADF (%)						
1 st Cut	40.489	38.289	36.089	33.889	$y = 40.489 - 0.022x$	0.99
2 nd Cut	40.096	37.686	35.276	32.866	$y = 40.096 - 0.0241x$	0.82
Pseudocolus ADF (%)						
1 st Cut	53.103	47.433	45.763	48.093	$y = 53.103 - 0.0767x + 0.0002x^2$	0.97
2 nd Cut	47.354	52.784	52.214	45.664	$y = 47.354 - 0.0843x - 0.0003x^2$	0.99
Leaf blade MM (%)						
1 st Cut	8.7174	11.1774	23.6374	46.0974	$y = 8.7174 - 0.0254x + 0.0005x^2$	0.99
2 nd Cut	7.8509	5.7309	5.2109	6.2909	$y = 7.8509 - 0.0292x + 0.00008x^2$	0.99
Pseudocolus MM (%)						
1 st Cut						
8	8.2659	7.6559	8.6459	11.2359	$y = 8.2659 - 0.0141x + 0.00008x^2$	0.99
16	8.692	7.792	8.692	11.392	$y = 8.6920 - 0.018x + 0.00009x^2$	0.99
2 nd Cut	7.8067	5.3267	4.4467	5.1667	$y = 7.8067 - 0.0328x + 0.00008x^2$	0.99

167 In the first cut, there was interaction between the N doses and the cutting heights for crude
168 protein content in the pseudocolus, according to Table 2. At the cutting height of 8 cm, the
169 point of maximum CP content (6.67%) was reached at a dose of 217.50 kg ha⁻¹ of N,
170 compared to 6.18% at the 16 cm height combined with the dose of 243.33 kg ha⁻¹ of N
171 (Table 2). At 24 cm height, 0.0108% increase in CP content per kg of N applied. This is
172 desirable because even though there is availability of potentially digestible fiber in pastures,
173 in the dry period protein is the nutrient that most limits animal performance [21]. According to
174 the authors mentioned in the references [22], for the cellulolytic bacteria of the rumen to be
175 well developed, the CP content should be higher than 7%.

176 In the second cut, there was an increase of 0.0058% in the CP content of pseudocolus per
177 kg of N applied (Table 2). According to the authors mentioned in the references [23], working
178 with marandu grass under four nitrogen doses (0, 100, 200 and 300 kg ha⁻¹ year⁻¹) and three
179 doses of phosphorus (0, 50 and 100 kg ha⁻¹ year⁻¹), also found that CP levels in the stem
180 increased according to the nitrogen rates, corroborating with the results obtained in the
181 present study. In addition, the authors mentioned in the references [24], working with N and
182 P levels in marandu grass, found that the highest CP levels in stalks were verified with the
183 application of the maximum level of nitrogen.

184 In the first and second cut, there was no interaction between the N levels and the cutting
185 heights for neutral detergent fiber (NDF) in the leaf blades (Table 2).

186 Contrasting results were reported by the authors cited in the references [25], stating that the
187 NDF levels in the leaf blade of the *Pennisetum purpureum* Shum (elephantgrass) in the
188 period of the waters increased as a function of the applied N doses, with values between
189 75.39 and 77.49% for the doses of 100 and 400 kg ha⁻¹ of N. It is worth noting that it is not
190 only the fertilization that regulates the fiber level of the bulk but also genetic aspects intrinsic
191 to the species / cultivar and environmental factors.

192 It is important to consider the effect of N on the nutritive value of the forage. The authors
193 cited in the references [26] observed that the increase of N could cause compensatory fall in
194 components such as the cell wall and change the NDF content of the forage. In addition, the
195 authors mentioned in the references [27], analyzing the NDF levels in marandu grass under
196 sources and doses of nitrogen, also found a reduction in the NDF content according to the
197 increase of nitrogen doses applied to the soil. In the first cut, there was a reduction of
198 0.036%, 0.0231% and 0.0199% in the NDF content in the pseudocolus kg of N applied, at
199 heights of 8, 24, 32 cm, respectively (Table 2). At the time of 16 cm the minimum of 76.87%,
200 was verified in the dose of N of 233, 60 kg ha⁻¹ of N. In the second cut (Table 2) was
201 obtained the maximum of 85.63% NDF in the pseudocolus in the dose of 132.33 kg ha⁻¹ of
202 N, which damages the consumption and the animal performance, since the NDF acts as
203 determinant factor of the process of ruminal repletion [28].

204 In the first and second cuts, there was a reduction of 0.022% and 0.0241% in the acid
205 detergent fiber (ADF) kg⁻¹ N applied in the piatã grass, respectively (Table 2). The authors
206 cited in the references [27] verified the ADF content was 34.06%, close to that observed for
207 the piatã grass in the sections analyzed. In contrast, the authors cited in the references [25]
208 observed that the levels of ADF in leaf blades increased (Table 1). In the experiment with
209 elephantgrass submitted to nitrogen fertilization (0, 100, 200, 300 and 400 kg ha⁻¹ of N)
210 linearly. According to the authors, this occurred due to changes in the structural components
211 of the plant resulting from the variation of stages of maturity accelerated by fertilization and
212 favorable climatic factors.

213 About pseudocolus ADF content, in the first cut, the minimum percentage (45.75%) was
214 verified at the dose of 191.75 kg ha⁻¹ of N. On the second cut, the maximum percentage
215 (53.28%) was observed at the dose of 140.50 kg ha⁻¹ of N (Table 2). The highest levels of
216 ADF in the whole plant in relation to leaf blades being attributed to the stem portion [25]. It is
217 therefore important that the stem fraction be of good nutritive value in order to depreciate the
218 quality of the roughage as little as possible.

219 The minimum mineral matter (MM) content in the leaf blades (5.49%) was verified in the
220 dose of 254 kg ha⁻¹ of N, in the first cut. In the second cut, the minimum content (5.19%) was
221 obtained in the dose of 182.50 kg ha⁻¹ of N (Table 2). These results indicate that the
222 increase of the nitrogen levels provided a dilution effect of the percentages of MM, possibly
223 due to the increase of the dry matter production of the forage. The authors cited in the
224 references [29] studying *Brachiaria* sp. and fertilization, observed ash contents of 11.9 and
225 10.4% for the Marandu and Decumbens grass under P application, values close to those
226 verified for the piatã grass in this experiment, of 8.72% and 7.85% for the first and second
227 cut, respectively.

228 In the first cut, minimum MM contents were observed in the dry mass of the piatã grass of
229 7.64% (88.12 kg ha⁻¹ of N) and 7.79% (100 kg ha⁻¹ of N) for the heights of 8 and 16 cm,
230 respectively. In the second cut, there was no interaction between the N doses and the cut
231 heights, only nitrogen effects on the MM contents in the piatã grass were observed. The
232 minimum ash content was 4.44% at the dose of 205 kg ha⁻¹ of N (Table 2).

233 Similar to the leaf blade fraction, the levels of MM in the pseudocolus decreased with the
234 increase of the nitrogen fertilization, corroborating with the results found by the authors
235 mentioned in the references [29] that suggested occurring dilution of the MM contents with
236 the increase in DM production, due to increases in nitrogen fertilization.

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238 **4. CONCLUSION**

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240 The cutting heights of 16 and 24 cm combined with doses of 200 to 300 kg ha⁻¹ of N promote
241 an increase in the agronomic and chemical-bromatological characteristics of the forage,
242 showing promising strategies to increase the productive efficiency in pasture systems.

243

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248

249 **COMPETING INTERESTS**

250

251 We declare that no competing interests exist.

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