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Original Research Article
**Reduction of the forage seeds physiological
quality by the contact with fertilizer in the crop-
livestock integration**

ABSTRACT

The aim of this study was to evaluate the effects of *Brachiaria* seed contact time with 05-25-15 fertilizer (N-P₂O₅-K₂O) on theseed's physiological quality. The experimental design was a completely randomized design with four replicates. Treatments were arranged in a5x4factorial, being: five seeds contact times with fertilizer (0, 24, 48, 72 and 96 hours); four forages: Marandu palisadegrass, Piatã palisadegrass, Xaraéspalisadegrass and Ruzi grass. The performed tests were: water content, germination (first count and germination percentage), tetrazolium (viability), electrical conductivity, accelerated aging, sand emergency and emergence speed index. Contact time of 05-25-15 fertilizer with *Brachiaria* seeds reduces linearly: germination, emergence and emergence speed index of *Brachiaria* seeds; Piatã and Xaraés palisade grass seeds viability; vigor (electrical conductivity), except in Ruzi grass seeds; and seeds germination of Piatã palisade grass submitted to accelerated aging test (vigor). Piatã palisade grass is the least recommended, among the analyzed grasses, for intercropping in simultaneous sowing.

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Keywords: *germination; marandupalisadegrass;piatãpalisadegrass; ruzigrass;vigorxaraéspalisadegrass.*

1. INTRODUCTION

The Central-West region has maintained monoculture and conventional agriculture for decades, as well as livestock activity with pastures in an advanced degradation stage. Reduction in fertility and low soil water retention in degraded pasture areas reduce the quantity and quality of feed offered to animals [1], compromising cattle potential productive, as well as negatively impacting the environment. In addition to the problems of monoculture and area degradation, the cattle potential productive is reduced due to the forage production seasonality.

Also, there is a need to increase the income of agriculture, due to the increasing food demand, the need to reduce opening of new areas by existing laws, and reduce the greenhouse gases emission [2,3]. An alternative to mitigate these impacts and promote socioeconomic and sustainable development is the integrated crop-livestock system (ICLS), through the consortium of grain crops, such as maize, with forage plants, mainly the *Brachiaria* (Syn. *Urochloa*) genus, increasing the production system efficiency [3].

In the ICLS, in case of the consortium of grain crops, such as maize, with forage plants, such as *Brachiaria*, the simultaneous sowing can be used to minimize problems such as lack of uniformity and reduced initial forage stand due to the reduced size and low weight of *Brachiaria* seeds. *Brachiaria* seeds are mixed with fertilizer recommended for sowing the

34 grain crop, being distributed at the same depth. Thus, the fertilizer will be used partially by
35 the forage, which will show slow development until the grain harvest.

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37 However, there's a possibility of damage to the forage seeds physiological quality[4],
38 resulting in economics losses due the lower initial stand and consequent lower forage
39 production, due to the fertilizer harmful effects on seeds. Results shows that
40 *Brachiariabrizantha*[5] and *Brachiaria ruzizensis*[6]contact timewith fertilizer, decreased the
41 seeds germination and vigor. Therefore, it was aimed to evaluate the effects of *Brachiaria*
42 seed contact time with 05-25-15 (N-P₂O₅-K₂O) fertilizer on the forage seed physiological
43 quality.

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46 2. MATERIAL AND METHODS

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48 The experimental design was a completely randomized design with four replicates. The
49 treatments were arranged in a 5x4 factorial, being: five *Brachiaria* seedscontact times (0, 24,
50 48, 72 and 96 hours) with 05-25-15 (N-P₂O₅-K₂O) fertilizer, commonly used in maize crop
51 sowing; four forages:*Brachiariabrizantha* (cv. Marandu, BRS Piatã e Xaraés),
52 (Marandupalisadegrass,piatãpalisadegrassandxaraéspalisadegrass, respectively)
53 and*Brachiaria ruzizensis* (cv. Kennedy), (Ruzi grass).

54 Based on the cultural value of the forage seed lots, the sowing rate of 4 kg of pure viable
55 seeds per hectare and the fertilizer quantity of 100 kg P₂O₅ ha⁻¹, required for sowing corn,
56 the ratio between seeds and fertilizer was adjusted.

57 Elapsed pre-established times, fertilizer and seeds were separated, and the following tests
58 were carried out: water content, germination (first germination count and germination
59 percentage), tetrazolium (viability), electrical conductivity, accelerated aging, emergence in
60 sand and emergence speed index.

61 To quantify water content, three samples of 4.0 g were used for each treatment, which were
62 placed in an oven for 24 hours at a temperature of 105 ± 1°C. After the drying process the
63 samples were placed in desiccators to promote the cooling and then the weight was
64 obtained using an analytical balance (0.0001 g) [7].

65 The methodology used for the germination test was described in the Seed Analysis Rule [7],
66 using four subsamples of 50 seeds of each forage species and fertilizer contact time with the
67 forage seeds. The forage seeds were equidistantly distributed in "gerbox" type germination
68 boxes, on two sheets of blotting paper as substrate, and moistened with distilled water in the
69 proportion of two and a half times of the paper dry mass.

70 Subsequently, they were taken to the biochemical oxygen demand (BOD) chamber with
71 photoperiod regulation of 12 hours and alternating temperature of 35/20 °C. Forage seeds
72 were analyzed at seven and 21 days, considering that the seeds that had emitted 2 mm of
73 primary root germinated.

74 For tetrazolium test, four subsamples of 50 seeds were used for each forage species and
75 the fertilizer contact time with forage seeds. The seeds were pre-wetted between paper
76 sheet for germination, conditioned in a BOD chamber with a temperature of 30 ° C for 18
77 hours without light. Then, the longitudinal sectioning of the seeds was performed, and one
78 part of the seeds was immersed in 0.5% tetrazolium salt solution (2,3,5-triphenyl chloride-
79 tetrazolium). It was placed in a BOD chamber at a temperature of 30 °C for 3 hours for

80 staining the living tissue of forage seeds. In the sequence it was classified into viable and
81 non-viable seeds[7].

82 In electrical conductivity analysis, four subsamples of 50 seeds were used for each
83 treatment, which were weighed in an analytical balance (0.0001 g), placed in a container
84 containing 75 mL of distilled water and conditioned in a BOD chamber with a temperature of
85 25 ° C for 24 hours, without light. Then, the exudates released through the conductivity
86 meter were measured [8].

87 The methodology of Marcos Filho (1999) was adopted for accelerated aging analysis, in
88 which the seeds of each treatment were distributed on aluminum screen coupled to
89 gerboxes containing 40 mL of distilled water. The boxes were then capped, forming a wet
90 chamber, and placed in a BOD chamber for 36 hours at 42 ° C, without light. Finally, the
91 germination test was carried out with the aged forage seeds [7].

92 For emergency sand test, sowing was carried out in trays (29.1 x 23.0 x 5.3 cm) with 2.5 kg
93 of sterilized sand at 105 ± 1 °C for 24 hours. Seeds were seeded for each treatment, in 10
94 mm depth, maintained at 12 hours of light incidence and humidity around 65% of the field
95 capacity, for daily maintenance of the initial weight [9]. Daily analysis of the seeds was
96 performed up to 21 days, considering seedlings with 2 mm above the substrate level
97 emerged at least. Subsequently, emergency speed index (ESI) was calculated using the
98 Maguire method [10].

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100 In variance analysis was considered the forage species effect, contact time and the
101 interaction between them. For contact time analysis, a linear regression test was performed
102 for each forage, and the coefficients were submitted to the t test. For all tests it was
103 considered a 5% probability level.

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105 3. RESULTS AND DISCUSSION

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107 It was verified that there was contact time effect and no interaction between forages and
108 contact times (Table 1), which shows that seeds contact time with 05-25-15 fertilizer does not
109 interfere in water content. An average water content of 11.42% was observed.

110 **Table 1. Water content (WC; %) of seeds of Marandu palisade grass, Piatã palisade**
111 **grass, Xaraés palisade grass and Ruzi grass submitted to contact with fertilizer and**
112 **Linear Regression (L).**

| Analysis | Contact time (hours) | | | | | L |
|----------|----------------------|-------|-------|-------|-------|---------------------|
| | 0 | 24 | 48 | 72 | 96 | |
| WC | 11.44 | 11.44 | 11.37 | 11.39 | 11.46 | 0.997 ^{ns} |

113 ^{ns}: not significant at 5% probability (P = .05).

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115 The absence of a change in water content may have been due to the fact that the seed
116 mixture with fertilizer was stored in semipermeable packaging (plastic bags), making it
117 difficult to absorb air moisture by both components, as well as the establishment of
118 hygroscopic balance inside the package.

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120 Another factor is that the seeds hygroscopicity varies according to the chemical constitution,
121 especially the proteins, which have high affinity for water [11], and fatty acids that present a
122 hydrophobic characteristic, with an antagonistic relation to the seed's contents [12], besides
123 to being influenced by genetics, environmental conditions and plant traits [13]. Based on this,
124 it is inferred that the hydrophilic substances content of the species studied in this work may
125 be low.

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In contrast to what was observed in this work, the authors cited in the reference [5] observed an increase in water content of marandu palisade grass with contact time with 04-14-08 fertilizer (N₂-P₂O₅-K₂O; urea, triple superphosphate and potassium chloride), attributing this effect to the high hygroscopicity of urea, which may have transferred air moisture to seeds. One of the negative effects on the water content increase is the increase in seed's metabolic activity, providing lower physiological quality [6].

Corroborating the above results, the authors cited in the references [14, 15, 16] verified an increase in seeds water content of marandu palisade grass as the contact time with triple superphosphate, single superphosphate and potassium chloride, respectively. The authors justify these results due to the seed coat rupture and absorption of environment moisture, as a consequence of obtaining the acid phosphate fertilizers, and the high salinity index of potassium chloride. Although the fertilizer used in this work consists of single and triple superphosphate and potassium chloride, which constitutes high salt content and acid pH, the effect described above was not evidenced.

There was no effect of contact time and forage interaction on the first and final evaluation of the germination percentage of Brachiaria seeds (P = .05), (Table 2).

Table 2. First (1E) and final evaluation (FE) of seeds germination (%) of Marandupalisade grass, Piatã palisade grass, Xaraés palisade grass and Ruzi grass submitted to contact with fertilizer and Linear Regression (L).

| Analysis | Contact time (hours) | | | | | |
|----------|----------------------|-------|-------|-------|-------|--------|
| | 0 | 24 | 48 | 72 | 96 | L |
| 1E | 55.43 | 57.48 | 50.94 | 51.13 | 44.97 | 0.011* |
| FE | 59.80 | 64.21 | 54.96 | 55.83 | 47.46 | 0.001* |

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* Significant at 5% probability.

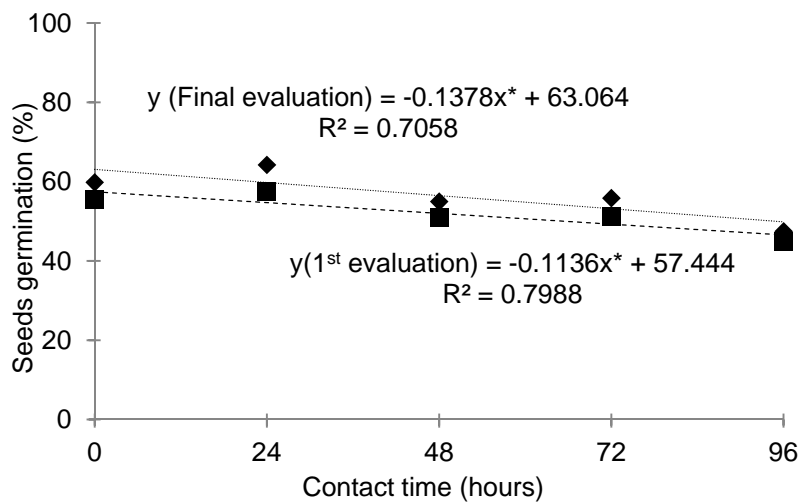
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There was a linear decreasing effect of forage seeds contact time with fertilizer on the first and final evaluation of seed's germination, regardless of the forage (Figure 1). Comparing the 96-hour treatment with the absence of contact, there was an average reduction of 18.87 and 20.63% in the first and final evaluation of the germination, respectively.



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156 **Figure 1. First and final evaluation of seeds germination (%) of Marandupalisade grass,**
 157 **Piatã palisade grass, Xaraés palisade grass and Ruzi grass submitted to contact with**
 158 **fertilizer and Linear Regression (L). *Significant at 5% probability.**
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160 Probably, the effect was justified by the tegument rupture and electrolytes extravasation,
 161 since the contact with fertilizer can act negatively on the seed coat and consequently inhibit
 162 the germination by the saline effect [17], besides the acid residues from the process of
 163 obtaining phosphate fertilizers [5]. Another influencing factor is probably the rapid water
 164 absorption by the seed during the imbibition phase, causing damage to seed tissues [18,19].
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166 The decrease in germination percentages obtained in first and final evaluation of germination
 167 test of forage seeds was also verified by the authors cited in the references [14, 5], indicating
 168 deleterious effect of marandu palisade grass seeds contact time with superphosphate
 169 fertilizers triple and formulated 04-14-08 on seeds vigor, with reductions of 95.74 and
 170 82.41%, respectively, in germination obtained with the first evaluation of the germination
 171 test. In addition, the authors also observed a reduction in seed germination percentage in
 172 the final evaluation of the germination test after being conditioned for a period superior to
 173 three and 36 hours, respectively.
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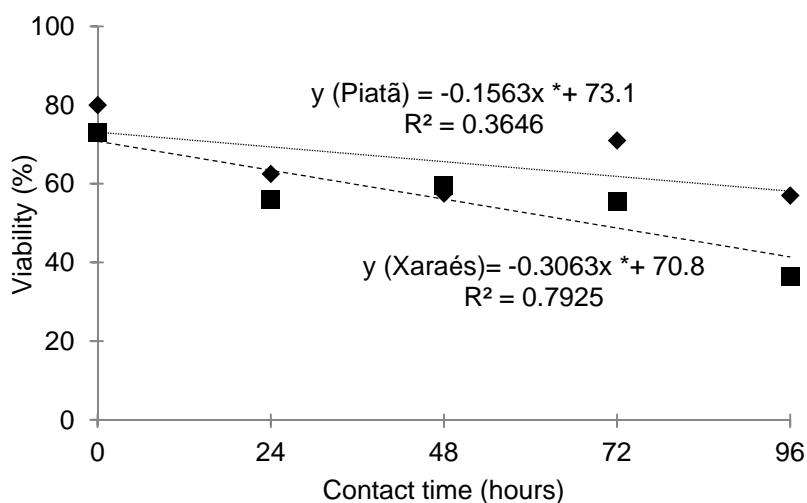
175 There was interaction effect of contact time and forage on viability ($P = .05$), (Table 3).
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 178 **Table 3. Seeds viability (%) of Marandupalisade grass, Piatã palisade grass, Xaraés**
 179 **palisade grass and Ruzi grass submitted to contact with fertilizer and Linear**
 180 **Regression (L).**

| Forages | Contact time (hours) | | | | | L |
|---------|----------------------|-------|-------|-------|-------|---------------------|
| | 0 | 24 | 48 | 72 | 96 | |
| Marandu | 76.00 | 70.00 | 70.50 | 73.50 | 72.00 | 0.390 ^{ns} |
| Piatã | 80.00 | 62.5 | 57.50 | 71.00 | 57.00 | 0.000 [*] |
| Xaraés | 73.00 | 56.00 | 59.50 | 55.50 | 36.50 | 0.000 [*] |
| Ruzi | 62.83 | 65.33 | 65.00 | 65.17 | 62.83 | 0.978 ^{ns} |

181 * Significant at 5% probability ($P = .05$); ns: not significant at 5% probability ($P = .05$).
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183 There was a linear decreasing effect of seeds contact time with fertilizer on the seed's
 184 viability of the Piatã and Xaraés palisade grasses (Figure 2).



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187 **Figure 2. Seeds viability (%) of Piatã and Xaraés palisade grass submitted to contact**
 188 **with fertilizer and Linear Regression (L). *Significant at 5% probability (P = .05)**
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190 Comparing the 96-hour treatment with the absence of contact, there was an average reduction
 191 of 28.75 and 50% in the seed's viability of the species, respectively. In addition, when
 192 analyzing the germination percentage at zero contact time and viability at the same time, the
 193 dormancy phenomenon is observed, as reported in studies of the authors cited in the
 194 references [20, 21] (Figure 2).
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196 In Piatã and Xaraés palisade grasses the seeds contact with fertilizer caused damage to seed
 197 embryos. Probably, due to the embryo exposure to the external surface, caused by tegument
 198 ruptures due to the high salinity, pH and electrical conductivity of the fertilizer. Based on the
 199 eminent effect only on the forage described previously, it is inferred that they have a tegument
 200 more susceptible to damages than the other forages studied.
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202 More vigorous seeds have higher soluble proteins amounts than those with less vigor [22].
 203 Therefore, it is necessary to study the constitution of seed cover of *Brachiaria* seeds and the
 204 use of Piatã and Xaraés palisade grasses in integrated systems under a simultaneous sowing
 205 system.
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207 In a tetrazolium test carried out on marandu palisade grass seeds, submitted to contact with
 208 granulated monoammonium phosphate, granular superphosphate and superphosphate
 209 powder, the authors reported in the reference [15] observed a linear decreasing effect of the
 210 contact time of all fertilizers with the seeds on viability.
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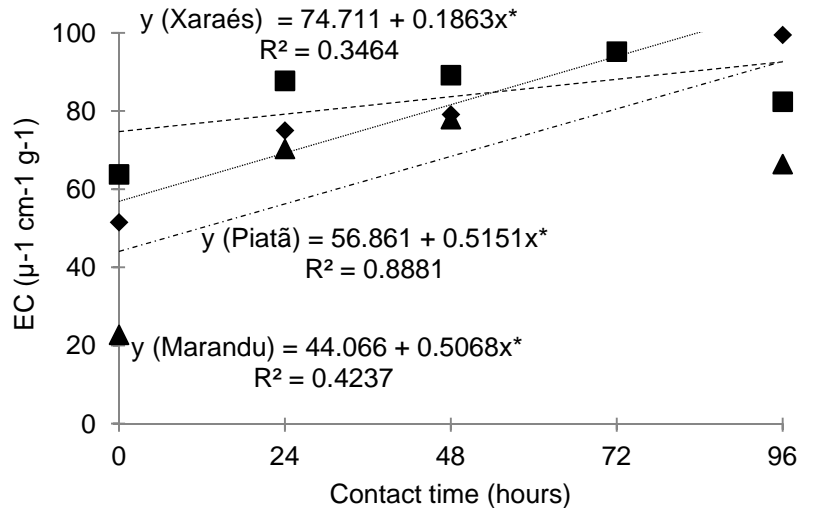
212 Interaction (P = .05) was observed between the forages and the contact time on the electrical
 213 conductivity, which shows that there was an effect of the fertilizer contact time for each
 214 *Brachiaria* cultivars. There was a linear effect of contact time with fertilizer on the electrical
 215 conductivity of all cultivars, except for Ruzi grass (Table 4).
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 219 **Tabela 4. Electrical conductivity ($\mu^{-1} \text{ cm}^{-1} \text{ g}^{-1}$) of seeds of Marandu palisade grass, Piatã**
 220 **palisade grass, Xaraés palisade grass and Ruzi grass submitted to contact with**
 221 **fertilizer and Linear Regression (L).**

| Forages | Contact time (hours) | | | | | L |
|---------|----------------------|-------|-------|--------|-------|---------------------|
| | 0 | 24 | 48 | 72 | 96 | |
| Marandu | 22.74 | 70.30 | 77.92 | 104.57 | 66.42 | < 0.0001 |
| Piatã | 51.53 | 75.02 | 79.13 | 102.76 | 99.47 | < 0.0001 |
| Xaraés | 63.78 | 87.72 | 89.16 | 95.21 | 82.39 | < 0.0001 |
| Ruzi | 57.44 | 91.76 | 53.51 | 55.31 | 67.64 | 0.284 ^{ns} |

222 * Significant at 5% probability (P = .05); ns: not significant at 5% probability (P = .05).
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224 As the seeds of Marandu, Piatã and Xaraés palisade grasses contact time with fertilizer
 225 increased, there was an increase in the electrical conductivity (Figure 3), which shows a
 226 reduction in seed vigor. When comparing the absence of contact with the maximum time
 227 studied in this work, it was verified that there was an average increase of 192, 93 and 29% in
 228 the electrical conductivity of the cultivars Marandu, Piatã, and Xaraés palisade grass,
 229 respectively.
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Figura 3. Electrical conductivity (EC; $\mu^{-1} \text{ cm}^{-1} \text{ g}^{-1}$) of seeds of Marandu, Piatã and Xaraés palisade grass and Linear Regression (L). *Significant at 5% probability (P = .05).

The results were because the 05-25-15 fertilizer consisted of monoammonium phosphate, single superphosphate, triple superphosphate and potassium chloride, and some of these fertilizers present acid residues or high salt content, which probably caused seed coat rupture and electrolytes release contained in the reserve substances [15] and is indicative of reduced vigor. In addition, in the electrical conductivity results, the fertilizer residue effect on the seeds outer layer can occur, since they were not washed before the beginning of the test.

Similar results were evidenced by [15, 16], who studied the contact of marandu palisade grass seeds with simple superphosphate and ammonium monophosphate in granulated, ground and powder forms; and potassium chloride, respectively, observed a proportional increase in these seeds electrical conductivity values.

The absence of effect of 05-25-15 fertilizer contact time on the electrical conductivity of Ruzi grass seeds should be studied, since this indicates a higher resistance of this species to physiological damages. Thus, it can be seen that up to 96 contact hours, there was no reduction in ruzi grass seeds vigor, which allows the producer greater flexibility in sowing activities, being able to carry out a mixture of seeds and fertilizers in advance.

There was an interaction effect (contact time versus forage grass) on seeds germination submitted to accelerated aging, therefore, an individual effect was evidenced for each forage tested. There was no effect of the contact time with fertilizer for the forage tested, except for Piatã palisade grass, in which a significant linear effect was observed (Table 5).

Table 5. Seeds germination (%) of Marandu palisade grass, Piatã palisade grass, Xaraés palisade grass and Ruzi grass submitted to contact with fertilizer after accelerated aging and Linear Regression (L).

| Forages | Contact time (hours) | | | | | L |
|---------|----------------------|-------|-------|-------|-------|---------------------|
| | 0 | 24 | 48 | 72 | 96 | |
| Marandu | 76,00 | 70,00 | 70,50 | 73,50 | 72,00 | 0,390 ^{ns} |
| Piatã | 80,00 | 62,5 | 57,50 | 71,00 | 57,00 | 0,000 [*] |
| Xaraés | 73,00 | 56,00 | 59,50 | 55,50 | 36,50 | 0,000 [*] |
| Ruzi | 62,83 | 65,33 | 65,00 | 65,17 | 62,83 | 0,978 ^{ns} |

262 * Significant at 5% probability ($P = .05$); ns: not significant at 5% probability ($P = .05$).

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264 Comparing the 96-hour treatment with the absence of contact, there was an average reduction
265 of 38.46% in seeds germination of Piatã palisade grass submitted to aging. The effect was not
266 evidenced in the other studied species studied (Figure 4).

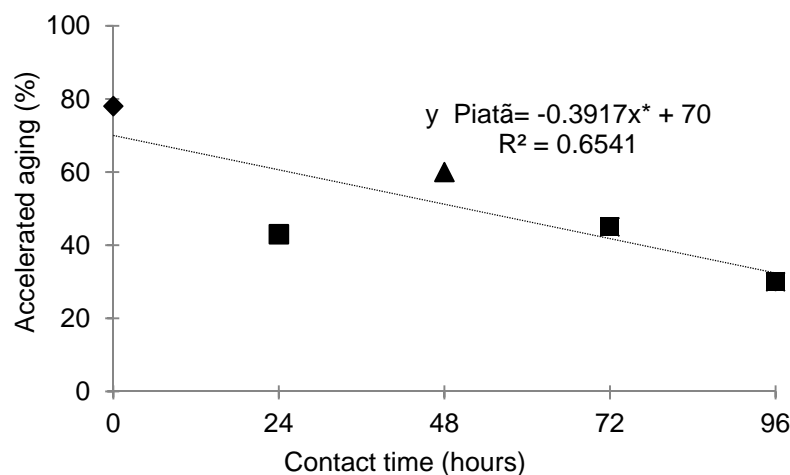
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268 The high temperature at which the seeds were submitted during aging may accelerate
269 deterioration process, as it causes degenerative changes in seed metabolism, such as protein
270 denaturation, besides to causing rapid dry seedsimbibition, which favors injuries, and / or
271 mobilization of reserves and energy release through respiration, culminating in reduced
272 germination after accelerated aging [23,24].

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274 Conversely, in some cases, there is an increase in germination after accelerated aging, which
275 may be associated with dormancy [25] or even with pathogen control.

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279 **Figure 4. Seeds germination (%) of Marandu palisade grass, Piatã palisade grass,**
280 **Xaraés palisade grass and Ruzi grass submitted to contact with fertilizer after**
281 **accelerated aging and Linear Regression (L). *Significant at 5% probability ($P = .05$)**

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283 The authors cited in the reference [25] evaluating seeds of *Brachiariabrizantha* cv. MG-5
284 Vitória, concluded that the accelerated aging method overcomes dormancy and favors seed
285 germination. However, the effect was only evidenced when accelerated aging was carried out
286 at 41 °C for a 96 hours period.

287

288 From the viability results (Table 3), electrical conductivity (Table 4) and accelerated aging
289 (Table 5), it is observed that Piatã palisade grass stands out from the other forages studied to
290 the effect of contact with fertilizer, presenting physiological damage more severe, intensified
291 by the increase in fertilizer contact time with the seeds. Therefore, precaution is recommended
292 in the use of Piatã palisade grass in detriment of the other forages studied for the crop-
293 livestock integration in simultaneous sowing system.

294

295 For the first and final evaluation of the emergence percentage, the effect of the seeds contact
296 time with fertilizer was observed. There was no interaction effect between forages and contact
297 time, therefore, for all the forage species analyzed, a similar effect was observed on the first
298 count and emergence percentage (Table 6).

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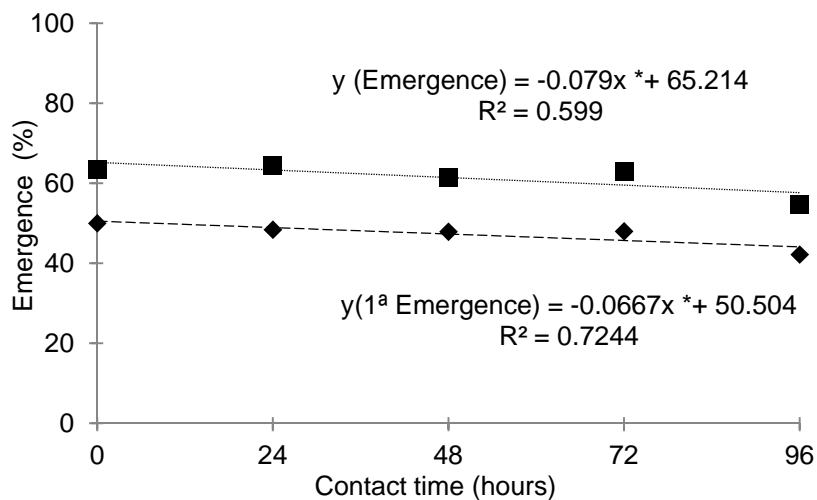
Tabela 6. First (1E) and final evaluation (FE) of seeds emergence (%) of Marandupalisade grass, Piatã palisade grass, Xaraés palisade grass and Ruzi grass and Linear Regression (L)

| Analysis | Contact time (hours) | | | | | |
|----------|----------------------|-------|-------|-------|-------|--------|
| | 0 | 24 | 48 | 72 | 96 | L |
| 1E | 50.00 | 48.41 | 47.90 | 48.00 | 42.20 | 0.006* |
| FE | 63.53 | 64.41 | 61.43 | 62.97 | 54.77 | 0.001* |

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* Significant at 5% probability (P = .05).

It was observed a reduction in the first and final evaluation of the *Brachiaria* seeds emergence with the increase of the contact time with the 05-25-15 fertilizer (Figure 5).



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Figura 5. First and final evaluation of seeds emergence (%) of Marandu palisade grass, Piatã palisade grass, Xaraés palisade grass and Ruzi grass and Linear Regression (L). *Significant at 5% probability (P = .05).

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Comparing the 96-hour treatment with the absence of contact, there was a mean reduction of 15.60 and 13.79% in the first and final evaluation of the emergence percentage, respectively (Figure 5).

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Studying emerged seedlings percentage of *Brachiariabrizantha* cv. MG-5 and the emergence speed, [4] observed damages by application of the 08-28-16 fertilizer next to the seed, regardless of the seeding depth. In this study, the authors reported a decrease in emergence percentage in Marandu palisade grass subjected to contact with 04-14-08 fertilizer and potassium chloride, respectively.

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Besides to direct damage caused by the contact of the fertilizer with the seeds, substances exuded from the seeds (mainly sugars) due to the tegument rupture (caused by high acidity, electrical conductivity and fertilizer pH) may have stimulated the development of microorganisms causing damage to seedling establishment.

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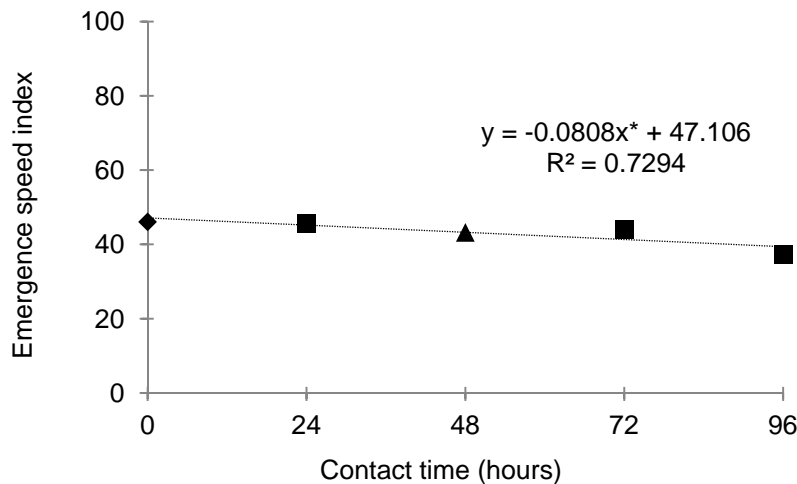
There was no interaction effect of contact time and forage on emergency speed index (ESI), (P = .05), (Table 7).

331 **Table 7. Emergence speed index (ESI) of Marandupalisade grass, Piatã palisade grass,**
 332 **Xaraés palisade grass and Ruzi grass and Linear Regression (L).**

| Analysis | Contact time (hours) | | | | | |
|----------|----------------------|-------|-------|-------|-------|--------|
| | 0 | 24 | 48 | 72 | 96 | L |
| ESI | 46.03 | 45.69 | 43.21 | 44.06 | 37.15 | 0.001* |

333 * Significant at 5% probability (P = .05).
 334

335 There was a linear decreasing effect of the seeds contact time with fertilizer on the ESI,
 336 independent of the forage species/cultivar (Figure 6). Comparing the 96-hour treatment with
 337 the absence of contact, there was an average reduction of 19.29% in ESI.
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340 **Figure 6. Emergence speed index of Marandu, Piatã, Xaraés and Ruzi grasses**
 341 **and Linear Regression (L). *Significant at 5% probability (P = .05).**
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344 The ESI reduction is a consequence of the interaction of seeds physiological potential with
 345 environmental conditions. Seed lots of forage species may have declined in physiological
 346 potential due to being subject to environmental changes, under conditions of temperature far
 347 from ideal, not withstand stress.
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349 Besides that, substances exuded from seeds (mainly sugars) due to tegument rupture (high
 350 acidity, electrical conductivity and fertilizer pH) may have stimulated the development of
 351 microorganisms, causing damage to seedling establishment.
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353 The ESI decrease of marandu palisade grass seeds with the advance of the fertilizer contact
 354 time was also verified by the authors cited in the references [14, 5] when using the
 355 superphosphate triple fertilizers and 04-14-08, respectively. The authors verified effect from
 356 12 and 3 hours of contact with fertilizers, respectively.
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358 **4. CONCLUSION**

359 Water content of *Brachiaria* seeds is not altered by the contact time with fertilizer 05-25-15.
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361 Contact time of 05-25-15 fertilizer with *Brachiaria* seeds reduces linearly: germination,
 362 emergence and emergence speed index of *brachiaria* seeds; Piatã and Xaraéspalisade grass
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364 seedsviability; vigor (electrical conductivity), except in Ruzi grass seeds; and seeds
365 germination of Piatãpalisade grass submitted to accelerated aging test (vigor).

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367 Piatãpalisade grass is the least recommended, among the analyzed grasses, for
368 intercropping in simultaneous sowing.

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371 **COMPETING INTERESTS**

372

373 We declare that no competing interests exist.

374

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