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Boron and zinc coating of *Brachiaria brizantha* cv. MG5 seeds

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Abstract

Brachiaria brizantha cv. MG5 has been increasingly used in pasture establishment to intensify production systems and increase yield and quality of forage. However, Brazilian soils are deficient in Boron and Zinc, which are essential elements for plant growth and development. Thus, to improve physical and chemical quality of *brachiaria* seeds, doses of boric acid (H_3BO_3) and zinc sulfate ($ZnSO_4.7H_2O$) were added to the calcium silicate and sand coating of the seeds, using a rotary coater. We tested 11 independent treatments in laboratory and greenhouse, where the seeds were evaluated for physical and physiological quality and the initial growth of the plants. At the end of the evaluations, the collected data were submitted to statistical analysis. There was an increase of up to 320% in seed mass with the seed-coating method tested. The treatment with 10 g H_3BO_3 + 5 g of $ZnSO_4.7H_2O.kg^{-1}$/seeds enhanced plant growth and did not affect the physiological quality of the seeds. Thus, the seeds are ready to be tested in the implementation of pastures. The combinations of 25g H_3BO_3 + 5 g of $ZnSO_4.7H_2O.kg^{-1}$ /seeds and 25g H_3BO_3 + 15g of $ZnSO_4.7H_2O.kg^{-1}$ /seeds reduced seed vigor and are not suitable for seed coating of *Brachiaria brizantha* cv. MG5.

Keywords: Boric acid, Zinc sulphate, Coating.

Abbreviations: ESC _ Emerged Seedling Count; ESI _ emergence speed index; GSI _ germination speed index; H_3BO_3 _ boric acid; IC _ intact control; PVA _ polyvinyl acetate polymer; SC _ uncoated scarified control; T0 _ coated control without fertilizer; T1 _ 20g of H_3BO_3; T2 _ 50g de H_3BO_3; T3 _ 10g of $ZnSO_4.7H_2O$; T4 _ 30g of $ZnSO_4.7H_2O$; T5 _ 10g of H_3BO_3 + 5 g de $ZnSO_4.7H_2O$; T6 _ 10g of H3BO3 + 15g of ZnSO4.7H2O; T7 _ 25g of H3BO3 + 5 g de ZnSO4.7H2O; T8 _ 25g de H3BO3 + 15g de ZnSO4.7H2O
ZnSO4.7H2O _ zinc sulfate.

Introduction

The production of meat and milk are fundamental economic activities in many developing countries. To reduce production costs, most of the livestock is raised on pasture (Dias Filho, 2014). In Brazil, the land used for pasture reaches almost 160 million acres, but of these, almost 12 million acres are in degraded condition (IBGE, 2019).
Therefore, it is necessary to intensify forage production systems and increase biomass yield and quality. A positive effect has been reported with *Brachiaria brizantha* cv. MG5, due to its high nutritional value, high forage production, rapid regrowth after grazing, high annual yield, good adaptation to medium-fertility soils, and good response to fertilization (Carvalho et al., 2014).
The maximum yield potential of forage plants in pasture is achieved with suitable conditions of temperature, moisture, light, and nutrient availability and management. As pointed out by Oliveira et al. (2015), plant nutrition is a key factor in forage quality and yield.
Natural and human changes in the environment have rendered most part of Brazilian soils deficient in important micronutrients such as Boron (B) and zinc (Zn). These micronutrients are essential to plant growth and their deficiency, or toxicity, impair several metabolic and physiological processes (Tavallali, 2017). Since these nutrients are required in low quantities, it is difficult to ensure an even distribution throughout the crop area. A promising alternative is to coat seeds with micronutrients, which may help germination, seedling emergence, and establishment in the field, especially in the initial phase of plant growth (Acha et al., 2016).
Therefore, the present work aimed to change the physical and chemical characteristics of *Brachiaria brizantha* cv. MG5 seeds by adding doses of boric acid and zinc sulfate to the calcium silicate and sand coating to improve initial plant growth and the physiological quality of seeds.

Results

The scarified and uncoated seeds (SC) of *Brachiaria brizantha* cv presented moisture content of 11.12%. Seed coating reduced water content by approximately 7 percentage points, showing significant difference when compared to the seeds of the SC treatment. Among the coating treatments, the moisture was stable regardless of the added doses of fertilizer, varying between 3.83% and 4.44%.
All the tested treatments increased seed mass and showed approximate gain of up to 320% (T8) when compared to the SC treatment. The treatments with individual doses of boric acid (T1 and T2) and zinc sulfate (T3 and T4), when analyzed separately, showed significant reduction in seed mass with the increase in the fertilizer dose. The treatments with combined H_3BO_3 and $ZnSO_4.7H_2O$ (T5, T6, T7 and T8) tended to increase the seed mass.

The levels of B and Zn, after the coating, increased with the increase in the doses of the fertilizers. There was a proportional reduction in the contents of these micronutrients in the treatments that had the doses of boric acid and zinc sulphate (Figure 1).
The association of the contents of B and Zn present in the fertilizers H_3BO_3 (17%) and $ZnSO_4.7H_2O$ (20%) with the content in the coated seeds showed that the adhesion rate of B and Zn remained uniform regardless of the fertilizer doses, when evaluated separately. The adherence rate of B ranged from approximately 7% to 13%, while for Zn, the variation among treatments with zinc sulfate ranged from approximately 27% to 34%. Therefore, all tested treatments presented higher adherence rate for Zn than for B.
Considering the physiological quality of the seeds, the germination rate of intact seeds (IC) was approximately 58% in paper roll and 37% in sand, both in laboratory conditions, not showing significant difference from chemically scarified seeds (SC) germinated on both substrates. After the coating and germination in paper roll, the brachiaria seeds showed no significant changes in the germination percentage in relation to the SC treatment (57%), except for the treatments T7 (36.5%) and T8 (21.5%). In the same environmental conditions, the treatments T7 (19.5%), T8 (13.5%), and T2 (23%) sown in sand also had significantly reduced emergence in relation to SC (43.5%). The treatment T8 stood out negatively on both substrates, with greater reduction in germination and emergence, approximately 35 and 30 percentage points, respectively, when compared to SC.
Regarding seed vigor (Figure 2), seedling formation in the sand substrate (ESI) was slower than in paper roll (GSI), in all treatments. The chemical scarification of brachiaria seeds significantly accelerated the germination of uncoated seeds (SC) in paper roll, but was not significantly different from sand. The seed vigor in both substrates was similar and the treatments T0 and T3 presented the highest GSI and ESI, opposite to the results found in treatment T8.
Still in relation to seed vigor (Figure 2), root growth had similar behavior to seedling formation speed, with lower peaks at higher fertilizer doses. There was no significant difference for this variable when comparing the treatments T0 (4.84) and T5 (4.87) with SC (6.10). Treatments with the highest doses of H_3BO_3 - T2 (1.99) or $ZnSO_4.7H_2O$ - T4 (1.65), caused significant reduction in root growth when compared with SC (6.10) and T0 (4.84).
During the emergence assessment period (30 days), the maximum and minimum temperatures recorded inside the greenhouse were 37ºC and 15ºC, respectively. In these conditions the seeds from the IC treatment reached the highest emergence percentage (72.5%), followed by treatments T0 (63.5%), T3 (61.5%), T4 (61.5%) and T5 (65.5%), with no significant differences among them. The treatment SC reached mean emergence rate of 50%, which was significantly lower than the treatment with intact seeds (72.5%). The SC treatment was superior only to the treatments coated with zinc sulfate combined with 25g of $H_3BO_3.kg^{-1}$/seeds, that is, T7 (27%) and T8 (25.5).
In the greenhouse, the coated seeds of brachiaria showed a faster response (ESI) with the treatment T0 (0.90), followed by the treatments T3 (0.94), T4 (0.83) and T5 (0.76), with no difference from the treatment IC (0.82). The presence of boric acid in the coating of brachiaria seeds tended to reduce ESI when compared with the other treatments.
The nutritional analysis of the plants grown in the greenhouse showed that there was no significant difference in the contents of boron and zinc in the shoot and roots for any of the treatments tested. The accumulation of zinc in the shoot varied between 17.97 $mg.kg^{-1}$ (SC) and 29.77 $mg.kg^{-1}$(T2), while boron accumulation ranged from 7.76 $mg.kg^{-1}$ (T6) to 13.81 $g.kg^{-1}$(T7). In the roots, the accumulated B and Zn contents were higher, with means of up to 43.58 $mg.kg^{-1}$ and 38.06 $mg.kg^{-1}$, respectively. However, differently from the shoot, the accumulation of B in the roots was higher than the accumulation of Zn, in all treatments.
Silicon was absorbed by the plants, with higher accumulation in the shoot, reaching contents of approximately 14 $g.kg^{-1}$ of dry mass, while in the roots, the maximum rate of accumulated silicon was around 2.5 $g.kg^{-1}$.
The plants of *Brachiaria brizantha* cv. MG5 originated from the coated seeds and grown in the greenhouse reached approximately 70 cm of shoot height, root length greater than 37cm, and dry mass of shoot and root around 7 and 14 g. $plant^{-1}$, respectively.
The maximum growth values were obtained with the coating treatment of 10g H_3BO_3 + 5g of $ZnSO_4.7H_2O$ kg^{-1}/seeds (T5) and had no significant statistical difference when compared with the control treatments, with and without coating.
Significant difference was found for all the assessed growth variables in the treatments tested with the minimum (T5) and maximum (T8) combinations of boric acid and zinc sulfate.

Discussion

The results show that the time and temperature used for the drying pellet process were efficient to produce a dry coating. This is an important characteristic for coating quality because a high-water content can cause the coating to break or disintegrate during the handling of seeds, affecting the physiological quality of the seed during the storage period (Carvalho and Nakagawa, 2012).
The coating material applied in the present study increased the mass of the brachiaria seeds, improving seeding precision and uniformity. However, in the tested conditions, it is important to pay attention to the amount of the fertilizers added individually in order to avoid further material loss. The excess of one-size particles may prevent the binding of the filler (calcium silicate + sand). Consequently, this could reduce seed mass even when increasing the amount of the fertilizer.
The contents of B and Zn in the coated seeds (Figure 1) shows that increase or decrease in the doses of H_3BO_3 and ZnSO4.7H2O affected the content of these micronutrients depending on the dose added. These results demonstrate that the filler was the greatest loss that occurred during the coating process and can be explained by the concept developed by McGeary (1961), in which optimum coating is achieved when the size and proportion of the particles are suitable, favoring perfect packing.
The adherence rates of B and Zn was not consistent with the proportion of doses tested in the present study. Even though the doses of H_3BO_3 were higher, the adherence rate of Zn was higher than that of B, which may be related to density of the fertilizers of 1.97g $/cm^3$ for zinc sulphate and 1.44g/cm^3 for boric acid, respectively. Density is the ratio of mass to volume of a given material. Thus, the lower the density of a material the more it takes up space.

Due to its lower density, H_3BO_3 was more easily dispersed with the rotation of the coater and adhered to the coater wall because of its greater volume. On the other hand, the higher density of $ZnSO_4.7H_2O$ facilitated its binding to the seeds with the adhesive solution. According to Acha et al. (2018), working with *Neonotonia wightii* seeds, the addition of H_3BO_3 and ZnSO4.7H2O during the single layer coating favors the adhesion of Zn, precisely because the ZnSO4.7H2O has a higher density than H_3BO_3. The authors of this work did not observe this result when these elements were distributed in different coating layers.
Seed dormancy is an important characteristic of many forages such as *Brachiaria brizantha*. Dormancy can be associated with physiological causes or barriers in the integument, which prevent gas exchange. It must be overcome to allow uniformity in germination and emergence (Carvalho and Nakagawa, 2012). Romani and Carvalho (2016) found that the treatment with H_2SO_4 was able to break the dormancy of these seeds. However, in the present study, no significant difference was found in the variables of germination between the intact control (IC) and the chemically scarified (SC) treatments (Figure 2). Therefore, we can affirm that the commercial seeds of the 2017/2018 harvest were not dormant during the experimental period. Nonetheless, all the seeds were chemically scarified with H_2SO_4 before the coating process to ensure uniformity of plant establishment from the pellets. In addition, Custódio et al. (2011) affirm that the chemical scarification of *Brachiaria brizantha* cv. Marandu seeds before pelleting created better conditions for performance with increased water restriction. The authors attributed this advantage to a reduced water demand, as the seeds have less tissues to be hydrated.
Imbibition during germination allows seeds to absorb B in a passive manner. However, during germination, seeds do not have physiological mechanisms sufficient to control the entry of this micronutrient, which in high concentrations can be absorbed until reaching phytotoxicity, causing physiological damage or even embryo death (Pessoa et al., 2000; Silva-Matos et al., 2017). Thus, it is likely that the low percentages of germination and emergence in treatments T7 and T8 resulted from the osmotic effect caused by the H_3BO_3 salt, and the same reason for the negative response of treatment T2 in sand. These treatments, therefore, are not considered suitable seed coatings because they decrease and delay the formation of normal seedlings and can result in uneven plant stands, reducing yield. Similarly, Farooq et al. (2011) observed that rice seeds treated with solution of 0.5% B, relatively concentrated, completely suppressed germination and seedling growth.
Throughout the stages of germination, the material applied onto the seed surface becomes a physical barrier that needs to be broken. Therefore, the material used in the seed coating must have good water solubility to reduce or prevent delays in radicle emergence. As shown in Figure 2, the coating material and fertilizer doses applied had no significant effect on GSI and ESI, except for treatments T7 and T8 in which the excess salt possibly delayed water absorption. However, the treatments T0 and T3 even provided higher GSI, allowing the seeds to perform a controlled imbibition; otherwise, it may cause physiological damage to the cell membrane (Derré et al., 2013).
The seeds sown in sand had a delayed response compared with sowing in paper roll. It can be argued that the sand substrate becomes another physical barrier to the seeds, with or without coating. The treatments T7 and T8, besides sowing in sand, received excess of salts in the coating, which caused an even greater reduction in ESI (Figure 2).
Root growth in ideal germination conditions is also a variable that indicates plant vigor (Nakagawa, 1999). In this study, the combination of the lowest doses of boric acid and zinc sulfate in T5 and the treatment without fertilizer application (T0) caused no harm to plant vigor (Figure 2). Therefore, these treatments provide a high quality coating and the seeds can be sown with micronutrients doses and without damage to the initial plant root development. On the other hand, in the treatments with higher doses of fertilizer, the high concentrations of soluble salts may have caused physiological imbalance, which resulted in root growth reduction, as reported by Hasana and Miyake (2017) in corn plants under salt stress.
Derré et al. (2013) built imbibition curves for coated and uncoated seeds of *Urochloa* and observed that the slow absorption of water in the coated seeds can hinder germination or ensure a uniform hydration even in the presence of soluble salts, which was also found in the present study.
The results in this work show that the absorption of B and Zn by *Brachiaria brizantha* cv. MG5 plants originated from seeds coated with fertilizer was not significantly higher than the amount needed at the growth stage the plants were in. Thus, plants accumulated great part of the micronutrients in the roots, which occurs when the supply rate is higher than the absorption rate (Zare et al., 2018). However, it is known that B and Zn are essential elements for plants, and their deficiency or toxicity causes dysfunctions in several metabolic and physiological processes (Tavallali, 2017). In this sense, making these micronutrients available is one of the benefits of coating seeds with fertilizers, when plants need them.
When assessing boron accumulation in the roots, it is important to consider that the demand for this element is inverse to the ability to absorb Si (Marschner, 1995). With regard to Si absorption, studies show that differences in the root anatomy of liliopsides in relation to magnoliopsides favor the Si absorption in these plants (Zargar et al., 2019). *Brachiaria brizantha* cv. MG5 is a liliopside, therefore, the easiness to absorb Si reduces the flow of B to the shoot, and hence, it accumulates in the roots. Freitas et al. (2015) also observed this inverse relationship in leaf of rice cultivar BRS Talento, in which the content of B decreased with the addition of Si in the solution.
Because Si increases the plant tolerance to several stresses, including the toxicity caused by excess of aluminum, sodium, iron, manganese, zinc, and boron in the soil (Júnior et al., 2013), the coating of grass seeds, such as *Brachiaria brizantha* cv. MG5, with calcium silicate can contribute to the germination and initial seedling development in unfavorable environmental conditions.
Marschner (1995) underlines that the physiological effects of nutrients in plants cannot be assessed separately. The interactions between nutrients can affect photosynthesis, respiration, utilization, and translocation of carbohydrates.

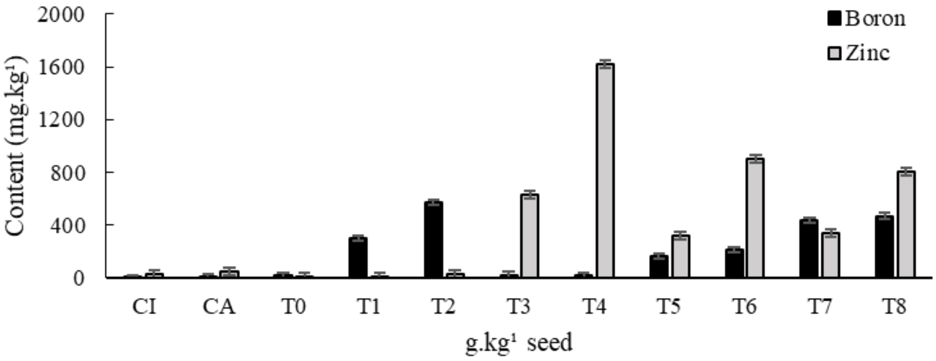

Figure 1. Boron and zinc content in coated seeds of *Brachiaria brizantha* cv. MG5. *Intact control (**IC**); uncoated scarified control (**SC**); coated control without fertilizer (**T0**). Doses of boric acid (H_3BO_3) and zinc sulfate ($ZnSO_4.7H_2O$) in g.kg^{-1}of seeds: 20 g of H_3BO_3 (**T1**); 50 g of H_3BO_3 (**T2**); 10 g of $ZnSO_4.7H_2O$ (**T3**); 30 g of $ZnSO_4.7H_2O$ (**T4**); 10 g of H_3BO_3 + 5 g of $ZnSO_4.7H_2O$ (**T5**); 10 g of H_3BO_3 + 15 g of $ZnSO_4.7H_2O$ (**T6**); 25 g of H_3BO_3 + 5 g of $ZnSO_4.7H_2O$ (**T7**); 25 g of H_3BO_3 + 15 g of $ZnSO_4.7H_2O$ (**T8**).

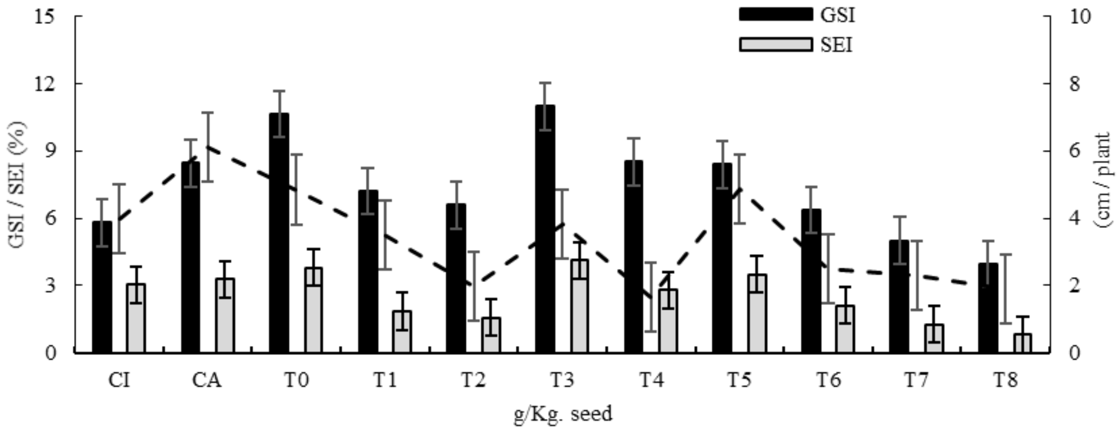

Figure 2. Germination speed index (GSI), seed emergence index (SEI), and root length of *Brachiaria brizantha* cv. MG5 in germination chamber. *Intact control (IC); uncoated scarified control (SC); coated control without fertilizer (T0). Doses of boric acid (H_3BO_3) and zinc sulfate ($ZnSO_4.7H_2O$) in g.kg^{-1}of seeds: 20 g of 20 g of H_3BO_3 (**T1**); 50 g of H_3BO_3 (**T2**); 10 g of $ZnSO_4.7H_2O$ (**T3**); 30 g of $ZnSO_4.7H_2O$ (**T4**); 10 g of H_3BO_3 + 5 g of $ZnSO_4.7H_2O$ (**T5**); 10 g of H_3BO_3 + 15 g of $ZnSO_4.7H_2O$ (**T6**); 25 g of H_3BO_3 + 5 g of $ZnSO_4.7H_2O$ (**T7**); 25 g of H_3BO_3 + 15 g of $ZnSO_4.7H_2O$ (**T8**).

The results of this study suggest that the action of calcium silicate in the seed coating combined with 10 g H_3BO_3 + 5 g of ZnSO4.7H2O.kg^{-1} (T5) favored the growth of *Brachiaria brizantha* cv. MG with no loss of plant vigor when compared with the plants from the uncoated treatments (IC and SC). Thus, the treatments were able to meet the objectives of seed coating, that is, provide combinations that add value to the seeds without impairing plant vigor and growth.

Material and Methods

Seeds - Commercial seeds of *Brachiaria brizantha* cv. MG5 from the 2017/2018 harvest were used in the experiment. The seeds were placed in a hot air blower to remove straw and unfilled seeds.

Seed Coat

The seed coating method was adapted from the protocol described by Acha et al. (2016) for seeds of *Neonotonia wightii*. Seed coating was carried out using a bench-top stainless steel N10 Newpack® coater set at 75% of the maximum rotation (64.5 rpm). The binder solution was activated for two seconds, pumped at a pressure of bb 4 bar, and the hot air blower was set to operate at 50ºC for three minutes.

Samples of 100g of *Brachiaria brizantha* cv. MG5 seeds were scarified in concentrated sulfuric acid for 10 minutes. The seed coating protocol consisted of layers formed by two portions of 12.5g of filler and two sprayings of binder (Cascorez® Extra, a polyvinyl acetate polymer (PVA)) diluted in water heated to 70°C, at the 1:2 (v/v) ratio, respectively. The *brachiaria* seeds were coated with calcium silicate + sand (0.25mm) at the ratio 7:1 (g/g), such that 250g of the filler mixture resulted in 10 coating layers.

Treatments - The experiment consisted of 11 independent treatments, and the doses of boric acid and zinc sulphate were based on the recommendations by Acha et al. (2016) for perennial soybean seeds. The following treatments have been independently tested: intact control (**IC**); uncoated scarified control (**SC**); coated control without fertilizer (**T0**); and treatments added with doses (in g.kg^{-1} /seeds) of boric acid (H_3BO_3) and zinc sulfate ($ZnSO_4.7H_2O$) individual and combined: 20g of H_3BO_3 (**T1**); 50g of H_3BO_3 (**T2**); 10g of $ZnSO_4.7H_2O$ (**T3**); 30g of $ZnSO_4.7H_2O$ (**T4**); 10g of H_3BO_3 + 5 g de $ZnSO_4.7H_2O$ (**T5**); 10g of H_3BO_3 + 15g of $ZnSO_4.7H_2O$ (**T6**); 25g of H_3BO_3 + 5 g de $ZnSO_4.7H_2O$ (**T7**); 25g de H_3BO_3 + 15g of $ZnSO_4.7H_2O$ (**T8**). For tests performed in the laboratory, the treatments were tested in a completely randomized design. In the greenhouse, randomized blocks.

Material preparation

The fertilizers boric acid (17% B) and zinc sulfate (20% Zn) used in the treatments were crushed, sieved (0.25mm mesh), weighed, and added to the portions of filler in the fifth coating layer (Acha et al., 2018).
Following the coating process, the seeds were sieved (5mm round opening) and the larger pellets were discarded. The selected pellets were assessed for physical and physiological characteristics in laboratory and greenhouse conditions.

Laboratory tests

In laboratory, initially, the coated seeds were tested for moisture content using the oven method at 105°C and thousand-seed weight, using 8 replicates of 100 seeds based on the Rules for Seed Testing (Brasil, 2009). To determine the percentage and speed of normal seedling formation, germination and emergence tests were carried out in a completely randomized design, with 4 replicates of 50 seeds from each treatment. For the germination test, seeds were wrapped in paper moistened with water and sprayed with the fungicide Orthocid (0.2%). For the emergence test, the seeds were sown in 1cm-deep washed coarse sand in 800mL plastic boxes. The tests were carried out in a germination chamber (BOD), at temperatures alternating between 20-35ºC, 8 hours of light: 16 hours of dark, for 21 days. The substrate was daily watered. Seeds showing radicle protrusion (germination) and epicotyl emergence, both 1cm in length, were counted to determine the germination speed index (GSI) and emergence speed index (ESI) (Maguire, 1962; Brasil, 2009).
Seed vigor based on seedling development performance was also tested in laboratory, using the methodology described by Nakagawa (1999). Four replicates of 20 seeds from each treatment were wrapped in paper and placed in germination chambers at temperatures varying between 20-35°C, for 21 days. At the end of the test, 10 seedlings were randomly selected to assess the length of the main root (in $cm.plant^{-1}$).

Greenhouse tests

The experiment was carried out in a greenhouse, between June and August 2019. Seeds were sown in plastic pots (5L) filled with a substrate of washed coarse sand. The experiment was arranged in four randomized blocks. Each treatment consisted of five labeled pots with 10 seeds each. During 30 days, the seeds were watered twice a day, and the Emerged Seedling Count (ESC) was determined and minimum and maximum temperatures of the greenhouse were measured. After 30 days, the plants were thinned to up to 5 plants in each pot by selecting the most vigorous ones. The experiment was carried out until 80 days after sowing with daily watering and, at every 48h, received a volume of 300 mL of Hoagland with ionic strength reduced to 25%. The nutrient solution did not contain H_3BO_3 and $ZnSO_4.7H_2O$ used as source of boron and zinc (Hoagland and Arnon, 1950).
After the growing period in the greenhouse, the plants were removed from the pots, washed in containers with water, placed in labeled plastic bags, and taken to the laboratory. The shoot and root parts of the plants were evaluated. Height was measured with a metric ruler, and the material was dried in a forced air circulation oven at 65°C for 72 hours and dry mass was weighed in a digital scale (Acha et al., 2016).

Nutritional analysis B and Zn

The levels of B and Zn in the seeds, shoot, and roots of the plants grown in the greenhouse were determined by nitric acid digestion (Peters, 2005) and ICPE – 9000 reading. The yellow colorimetric method was used for silicon extraction (Si) (Korndorfer, et al. 2004). After the digestion protocol, the material was dried in an oven at 65ºC for 72 hours, milled, and four repetitions of 100mg were weighed for each treatment.

Statistical analysis

Data were tested for normality using the Lilliefors test and homoscedasticity using the Bartlett's and Cochran's tests and showed normal distribution. Variance analysis was carried out with the F test and means were compared by the Tukey's test at 5% probability, using the SAEG program.

Conclusion

The coating method applied to the seeds of *Brachiaria brizantha* cv. MG5 efficiently increased seed mass and formed an integral and water-soluble covering, providing a quality seed coating.
The treatment with 10g H_3BO_3 + 5g of $ZnSO_4.7H2O.kg^{-1}$ of seeds did not interfere with seed physiological quality and favored plant growth, thus the seeds are ready to be tested in the implementation of pastures.
The treatments 25g H_3BO_3 + 5g of $ZnSO_4.7H2O.kg^{-1}$ of seeds and 25g H_3BO_3 +15g of $ZnSO_4.7H2O.kg^{-1}$ of seeds reduced seed vigor of *Brachiaria brizantha* cv. MG5 and, therefore, are not indicated for coating.

References

Acha AJ., Vieira HD, de Souza C. L. M., da Silva FWA (2018) Methodology of applying different doses of boron and zinc in the coating of perennial soybean seeds. J Exp Agric Int. 26(5): 1-9.

Acha AJ, Vieira HD, Freitas MSM (2016) Perennial soybean seeds coated with high doses of boron and zinc. Afr J Biotechnol. 15(37):1998-2005.

Brasil. Ministério da agricultura pecuária e abastecimento. Regras para análise de sementes. Brasília, snda/dndv/clav, 2009. 395p.

Carvalho CABD, Peres AA, Premazzi LM, Malafaia P, Carvalho MIA, Paciullo DSC, Costa VAC (2014) Performance of dairy heifers raised on Xaraés palissadgrass (*Brachiaria brizantha* cv. Xaraés) pasture supplemented with two types of mineral mixture. Pesq Vet. 34 (1): 46-50.

Carvalho NM, Nakagawa J (2012) Sementes: Ciência, Tecnologia e Produção. 5. ed. 590p.

Custódio CC, Ambiel AC, Rodrigues DZ, Agostini EATD, Factur VD, & Pavanelli LE (2011) Peliculização de sementes intactas e escarificadas de Brachiaria brizantha (Hochst. ex A. Rich.) Stapf. Pesq Agro Tropical. 41(3), 314-321.

Derré LO, Custódio CC, Agostini EAT, Guerra WEX (2013) Obtenção das curvas de embebição de sementes revestidas e não revestidas de *Urochloa brizantha* e *Urochloa ruziziensis*. Colloq Agrariae. 9 (2): 103-111.

Dias-Filho MB (2014) Diagnóstico das pastagens no Brasil. Embrapa Amazônia Oriental-Documentos (INFOTECA-E).36p.

Farooq M, Siddique KH, Rehman H, Aziz T, Lee DJ, Wahid A (2011) Rice direct seeding: experiences, challenges and opportunities. Soil Till Res. 111 (2): 87-98.

Freitas LB, Fernandes DM, Maia SCM (2015). Silício na nutrição mineral e acúmulo de alumínio em plantas de arroz de terras altas. Pesq Agropec Tropical. 4(45):440-448.

Hasana R, Miyake H (2017) Salinity stress alters nutrient uptake and causes the damage of root and leaf anatomy in maize. KnE life sci. 219-225.

Hoagland DR., Arnon DI (1950) The water-culture method for growing plants without soil. Circular Calif Agric Exp Stn. 347(2. ed).

IBGE. (2019) Censo Agropecuário 2017.

Júnior LAZ, Carvalho-Zanão MP, Fontes RLF, Grossi JAS (2013) Produção de rosas influenciada pela aplicação de doses de silício no substrato. Rev Bras Ciênc Solo. 37(6): 1611-1619.

Korndörfer GH, Pereira HS, Nola A (2004) Análise de silício: solo, planta e fertilizante. Grupo de Pesquisa em Silício. Uberlândia, ICIAG-Universidade Federal de Uberlândia. 34p. (Boletim Técnico 1).

Maguire JD (1962) Speed of germination-aid selection and evaluation for seedling emergence and vigor. Crop Sci. 2 (1):176-177.

Marschner H (1995) Mineral Nutrition of Higher Plants. Academic. Press London 2.ed. 889.

McGeary RK (1961) Mechanical packing of spherical particles. J Am Ceram Soc. 44 (10): 513-522.

Nakagawa J (1999) Testes de vigor baseados no desempenho das plântulas. Vigor de sementes: conceitos e testes. Londrina: *ABRATES*. 1:1-24.

Oliveira VS, da Silva Morais JA, Fagundes JL, dos Santos Santana JC, Lima IGS, Santos CB (2015) Produção e composição químico-bromatológica de gramíneas tropicais submetidas a dois níveis de irrigação. Arch Vet Sci.20 (2): 27-36.

Pessoa ACS, Luchese EB, Luchese AV (2000) Germinação e desenvolvimento inicial de plantas de milho, em resposta ao tratamento de sementes com boro. Rev Bras Cienc Solo. 24 (4): 939-945.

Peters JB (2005) Wisconsin procedures for soil testing, plant analysis and feed & forage analysis: Plant analysis. Department of soil science, college of agriculture and life sciences. Madison, WI: University of Wisconsin-Extension.

Romani F, de Carvalho RIN (2016) Break dormancy, germination and vigor of *Brachiaria brizantha* cv. BRS Piatã. Rev Elet Cienc. UERGS. 2 (3): 235-239.

Silva-Matos RRSD, Albano FG, Cavalcante ÍHL, Pessoa Neto JA, Silva RL, Oliveira IVDM, Carvalho CIFS (2017) Desenvolvimento inicial de mudas de melancia cv. Crimson Sweet em função de doses de boro aplicadas na semente. Rev Bras Ciênc Agrár. 40 (4):30-39.

Tavallali V (2017) Interactive effects of zinc and boron on growth, photosynthesis, and water relations in pistachio. J Plant Nutr. 40 (11):1588-1603.

Zare AA, Khoshgoftarmanesh AH, Malakouti MJ, Bahrami HA, Chaney RL (2018) Root uptake and shoot accumulation of cadmium by lettuce at various Cd: Zn ratios in nutrient solution. Ecotoxicol Environ Saf. 148:441-446.

Zargar SM, Mahajan R, Bhat JA, Nazir M, Deshmukh R (2019) Role of silicon in plant stress tolerance: opportunities to achieve a sustainable cropping system. 3 Biotech. 9(3): 73.