Quality of *Stylosanthes* Campo Grande seeds coated with different materials[1]

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ABSTRACT

The seed coating technique adds value to the seeds. This technique allows changing the seed size and shape, facilitating sowing, and also the application of essential nutrients to the good development of the plant in the post-germination phases. Therefore, the objective of this work was to evaluate the physical and physiological characteristics of *Stylosanthes capitata/macrocephala* coated with different materials. For the coating procedure, a N10 Newpack bench seed coating machine was used. The experimental design was completely randomized, with four replications and 50 seeds per plot distributed in 10 treatments. The different materials and their respective mixtures significantly altered the physical characteristics, the weight of a thousand seeds (WTS), water content (SWC), maximum diameter (DMA), and minimum diameter (DMI) of the seeds. Among the different materials, the sand coated seeds had the highest germination percentage (%G), germination velocity index (GSI), and first germination count (FGC). The maintenance of physiological attributes was observed in sand coated seeds (0.25 mm). Therefore, it is an alternative application of nutrients via seeds, due to the inert character of the sand. The mixing of the materials used in this work is not recommended.

Keywords: coating machine; coated seeds; germination; sand.

INTRODUCTION

Since it was released in 2000, the use of *Stylosanthes capitata/macrocephala* cv. Campo Grande has increased due to its superior performance and the development of production technology (Fernandes *et al*., 2005). The use of high-quality seeds is a relevant practice for plant establishment and development on the field (Silva *et al*., 2016), specially, its physiological potential that is characterized by germination (viability) and vigor (Melo *et al*., 2015).

Vigorous seeds are capable of rapid and uniform emergence, with a consequent development of normal seedlings under various environmental conditions (AOSA, 2009). In this sense, with greater demand for seeds to compose pastures, it is especially important to use technologies to maintain the physiological potential of seeds. Seed coating techniques can be used (Sampaio & Sampaio, 2009) as a means of maintaining such characteristics.

Seed coating is a technique that has been used for a long time, especially in forestry and ornamentals. It consists of a mechanism of application of inert and adhesive materials aiming at increasing the seed size, as well as changing its shape and texture to facilitate direct sowing (Conceição *et al*., 2009).

For species that have small seeds such as vegetables and forage seeds, coating is a technique with great potential to make direct sowing viable for the following reasons: precision in sowing and seed density, reduction of production costs, reduction of impacts that seeds suffer during sowing, formation of a more humid microenvironment (Oliveira *et al*., 2003).

However, despite the technique being at an advanced level, the methodologies for its application are not available, because it is a trade secret of the companies (Funguetto, 2007). In addition, even when coating methodologies are available for one species, they do not apply to another one due to the specificities of each seed.

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Thus, the objective of this research was to study the effects of the initial physical and physiological qualities of *Stylosanthes capitata/macrocephala* cv. Campo Grande, coated with different of materials.

MATERIALS AND METHODS

Was used Seeds of *Stylosanthes capitata/ macrocephala* cv. Campo Grande purchased from the company BREEDS®, the seeds were subjected to manual scarification between two sheets of sandpaper number 100.

The coating materials and the binder used in the experiment were chosen according to the papers of Mendonça *et al.* 2007 and Xavier *et al*. 2015. The coating materials used were: sand (0.25 mm), dolomitic limestone and calcium silicate. A polyvinyl acetate (PVA) glue diluted in heated water to 70° C in proportion to 1/1 (v/v) was used as binder (Mendonça *et al*., 2007).

The ratio of coating material to seeds was 3:1 (w/w). The seed coating process was carried out using a Newpack® coating machine, model N10. Adjustment of the equipment settings and coating methodologies were adapted from Xavier *et al*. (2015).

The operational characteristics were adjusted in the Newpack® equipment model N10 at 50 °C for the temperature (T °C) and continuous speed of 12 m / s for the airflow (FA m/s).

The following characteristics were evaluated.

Seed Water Content (SWC)

It was determined using the drying oven method at 105 ° C ± 3 °C for 24 hours according to the recommendations described in the Regras para Análises de Sementes (RAS) (Brasil, 2009), with two replications of 4.5 ± 0.5 g each and the results expressed in percentages (on wet basis).

Weight of one Thousand Seeds (WTS)

Eight replications of 100 seeds were used, which were weighed on precision scales (0.0001 g) and the results expressed as mean weight (g) of one thousand seeds (Brasil, 2009).

Maximum (MAD) and Minimum Seed Diameters (MID)

Four replicates of 50 seeds were used for each coating treatment. The seeds were analyzed by the GroundEye® software image analysis system, which provided the maximum and minimum diameters of the seeds and the results were expressed in millimeters (mm).

Germination Test (% G)

It was carried out in a completely randomized design with four replications of 50 seeds per treatment using how substrate, on paper in gerbox previously moistened with water equivalent to 2.5 times the paperweight. The tests were mounted on in seed germinator at temperature 20 - 35 °C with a photoperiod of 8 hours of light and 16 hours of darkness for 10 days (Brasil, 2009). Daily counts were made to calculate the germination speed index (GSI) according to the formula proposed by Maguire (1962). On the fourth day, the first germination count (FGC) was made and on the tenth day the last germination counts to determine the germination percentage (% G).

Particle Density (PD)

It was determined by the volumetric balloon method (Embrapa, 1997).

The experiment was conducted in a completely randomized design with ten treatments each with four replications. The following treatments have been determined.

TR1 - (untreated) seeds; TR2 - Sand (300 g); TR3 - Dolomitic limestone (300 g); TR4 - Calcium silicate (300 g); TR5 - Sand (100 g) + Dolomitic limestone (200 g); TR6 - Sand (50 g) + Dolomitic limestone (250 g); TR7 - Sand (25 g) + dolomitic limestone (275 g); TR8 - Sand (100 g) + calcium silicate (200 g); TR9 - Sand (50 g) + calcium silicate (250 g); TR10- Sand (25 g) + calcium silicate (275 g).

The IVG and PCG data were transformed into “x and 1 / x, respectively, as they did not meet the requirements for homogeneity and normality of variance by the Bartlet and Shapiro-Wilk tests, respectively. After the presupposition was met the analysis of variance and the Tukey test were performed at the 5% probability level and Pearson’s correlation test at the 1 and 5% probability levels with the aid of The R Project for Statistical Computing (2015).

RESULTS AND DISCUSSION

All combinations of materials used as coating treatments increased the weight of one thousand seeds (WTS) as compared to the weight of uncoated seeds (TR1 - control), especially coating treatment 2 that consisted of sand (AR 300 g) (Figure 1).

Certainly, the significant difference of coating treatment 2 compared to the other treatments is correlated to the higher mean density of this material. The sand, dolomitic limestone and calcium silicate used in this work had densities of 2.93, 2.82 and 2.66 g.cm^{-3} respectively. Although they presented numerically close values, they statistically differed from each other by Tukey test (Figure 2).

The sand high density granted the seeds higher weights due, mainly, to the direct correlation between density and mass of 0.91 (figure 3). This behavior is more evident when descriptively analyzing the WTS curve (Figure 1) and the particle density graph (Figure 2), where a

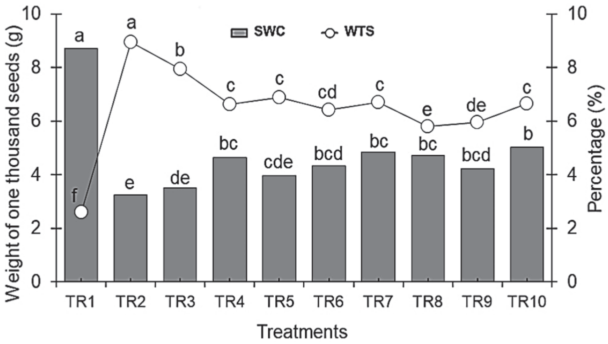

Figure 1: Weight of one thousand seeds (WTS) (g) and Seed water Content (SWC) of *Stylosanthes* cv. Campo Grande subjected to 10 coating treatments. Means followed by the same letter do not differ statistically by Tukey test at 5% probability within each variable level.

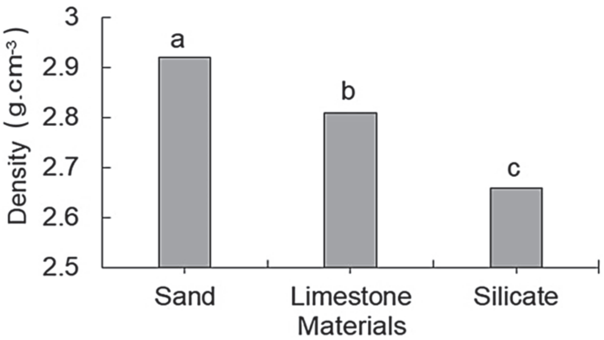

Figure 2: Particle density of materials used for seed coating *Stylosanthes* cv. Campo Grande. Means followed by the same letter do not differ statistically from each other by Tukey test at 5% probability.

linear trend between material typology and density is observed, thus directly affecting the WTS, i.e., the higher the density the greater the specific mass of the particles. Thus, the seeds covered with sand end up presenting higher WTS in relation to the seeds covered with limestone and silicate.

Xavier *et al*. (2015) observed increased WTS of *Stylosanthes* coated seeds with a magnitude of 1.55 to 2.3 times as compared to uncoated seeds. The same authors reported that the treatment that stood out was composed of limestone, sand and PVA with WTS of 5.59 g, showing that sand plays a direct role in this gain.

In the present research, the WTS values observed are relatively higher than those described by Xavier *et al*. (2015). Nevertheless, the results are in agreement with the reports of Silva *et al*. (2017) who observed WTS values of 8.5 g, which are about 3.26 times higher than the control ones.

In addition to the particle density, the Person correlation test showed that air flow (FA m/s) and temperature (T °C) directly influenced the coating process and, consequently, the WTS. Both variables presented significant correlation values (0.88 and 0.87, respectively), indicating that as air flow and temperature increase, so does WTS (Figure 3).

These variables are limiting to the coating process due to their importance in the layer formation and coalescence mechanisms, which depend on drying of the binder material resulting in particle agglomeration and, consequently, in the nucleus growth (the seed).

According to the results shown in Figure 3, these significant differences among treatments are also strongly correlated to the operating variables involved in the seed coating process, *i.e*., temperature (T °C) and air flow (AF m/s).

Thus, the typology of materials and their physical characteristics lead to different outcomes during the coating process. Similarly, to WTS, the SWC were influenced by the sand density, due to the specific particle weight, which resulted in higher dry weight of seeds and consequently lower values of SWC.

This behavior was also observed in the work of Conceição *et al*. (2009) in which the coating rendered the seeds a lower water content as compared to the treatment without coating. In the same study, the authors observed that removing the seed coat, moisture values increased to the same percentage of bare seeds.

In the coating process, the drying step resulting from the combined effects of airflow and temperature is crucial for the formation of the layers. The methodological adjustments of these variables are decisive for establishing minimum water contents in the coverings that will not compromise the physiological characteristics of the seeds.

All facts considered, the results presented in this paper are in agreement with the findings of Xavier *et al*. (2015) showing drying efficiency in the seed coating process, with adjustments in the methodology. Despite being above the recommended drying temperature that should not exceed 40 °C for the risk of impairing the physiological characteristics of seeds (Carvalho & Nakagawa, 2012). The increase in temperature counterbalanced the addition of two seconds to binder spraying time, favoring the coating by granting more uniform and larger layers to the resulting seed coat.

In Figure 4 the significant differences among the effects of the coating materials on maximum diameter (MAD) and minimum diameter (MID) can be observed. Calcium silicate treatment TR4 (SI 300 g) seed mean was statistically superior to those of the seeds from other coating treatments. This significant difference correlates with the density of the materials used for seed coating as observed in Figure 3.

The values of seed MAD and MID negatively correlated with density and coefficients of - 0.85 and - 0.64 were observed, respectively, indicating an inversely proportional effect on the variables. The effect of the coating materials on both variables is characterized by significant differences among the effects of coating treatments without the mixture of sand in their composition, that is, TR2, TR3 and TR4, demonstrating an inversely proportional effect; the higher the density, the lower the particle size, MAD and MID.

It was observed that seeds coated with TR2 (AR 300 g), TR3 (CA 300 g), TR4 (SI 300 g) and TR5 (AR 100 g + CA 200 g) did not differ from uncoated seeds (control). These results indicate that even coated with these materials the seeds preserved their physiological quality, that is, the seed vigor (Figure 5). These results also indicate less dispersion of seed data from treatments TR2, TR3, and TR5 as compared to the control treatment. This effect is certainly related to the typology of the materials. Comparing TR4 seed data with data resulting from sand mixtures, a smaller dispersion is observed for seeds coated with TR8, TR9, and TR10, however, there is a decrease in the FGC percentages.

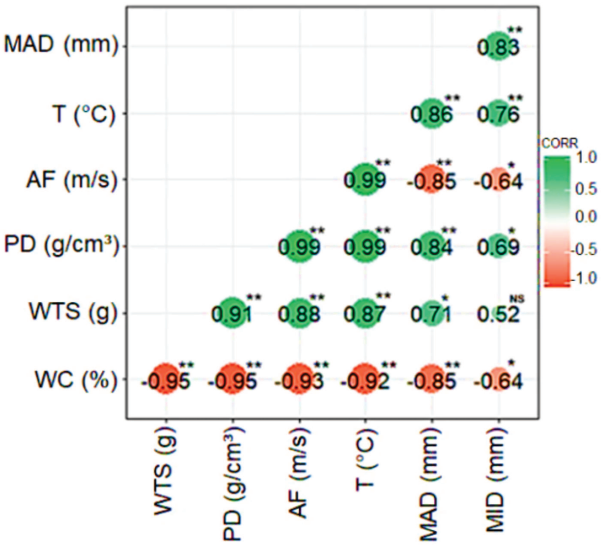

Figure 3: Correlogram of the physical variables of *Stylosanthes* cv. Campo Grande. [ns] Not significant, * significant at 1% probability, ** significant at 5% probability. AF (m / s) - air flow; PD (g cm^3) - Particle density, WTS (g) - Weight of one thousand seeds; MID (mm) - Minimum diameter; MAD (mm) - Maximum diameter; SWC (%) – Seed Water content; T (° C) - Temperature.

Decreases in these physiological characteristics may be related to the rate of water absorption and retention by coatings that exert a barrier to water molecules, slowly released during the initial germination processes (Tao *et al*. 2018).

Although not significant difference regarding, the means of treatments TR2, TR3, TR4, and TR5 compared to the means of treatment TR1 (control), numerically the seeds coated of these treatments suffered delay (FGC) caused by the coatings. This delay was potentiated when sand was mixed with calcium silicate or dolomitic limestone. This indicates that mixing limestone and silicate with sand can compromise the physiological characteristics of seeds. These lower (FGC) values may be related to the particle size of the silicate and limestone coating materials. Because as the layers of materials with smaller particles form, this makes the coating more waterproof, with the reduction of pore spaces, since materials with smaller particles have smaller pore sizes. Oliveira *et al*., (2003) observed that limestone can make the coating more waterproof.

Xavier *et al*. (2015), studying the effect of coating with different materials on the physiological potential of perennial soybean seeds observed that the coating directly affected negatively the imbibition speed of the seeds, compromising the first phase of the three-phase standard proposed per Bewley & Black (1994). Derré *et al*, (2013) studying the behavior of coated and uncoated seeds of *Urochloa brizantha* cv. Xaraés and *Urochloa ruziziensis* cv Kennedy observed than uncoated seeds absorbed water more quickly than coated seeds. Ferreira *et al*. (2015) observed that in six lots of coated hybrid Brachiaria, occurred a 60% decrease in the first germination count as compared to uncoated seeds.

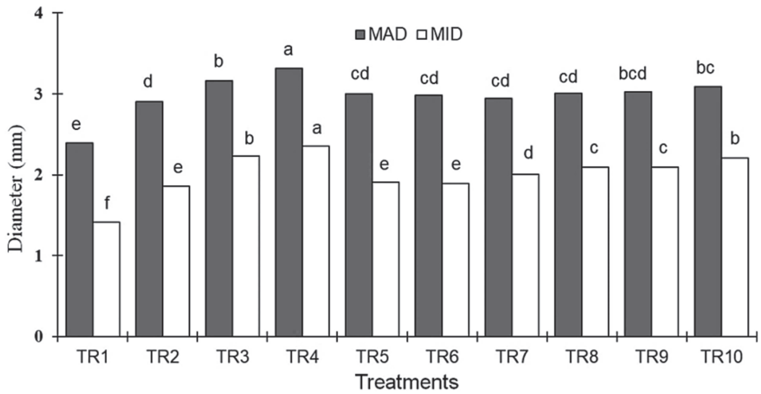

Figure 4: Maximum diameter (MAD) and minimum diameter (MID) of styling cv. Campo Grande undergoing 10 treatments. Means followed by the same letter do not differ statistically by Tukey's test at 5% probability at each variable level.

Similar behavior was observed for the germination speed index (GSI): the uncoated (control) and sand coated seeds (AR 300 g) did not differ from each other (Figure 6).

This behavior explains the high FGC means for these same treatments. This index is directly related to FGC in the different substrates. The higher GSI means, the higher the FGC values observed. According to Guimarães *et al.*, (2020), uncoated seeds have higher GSI values than the coated seeds. This behavior is attributed to the layers that surround the coated seeds causing a delay in FGC and GSI, due to the decreased water diffusion from the environment to the seeds.

In germination percentage (%G), seed from coating treatments TR2, TR3, TR4 and TR5 did not differ from uncoated seeds (control). (Figure 7).

The results found for seeds indicate that over time they managed to standardize since seeds from treatments TR3, TR4 and TR5 had a statistically different GSI from the control. The major problem in coating seeds is the delay in germination and emergence, caused by the physical barrier provided by the coating. In the TR4 this effect is noticeable, although they are statistically equal to control, the coated seeds obtained higher unevenness due to the barrier of the coating. According to Silva & Nakagawa (1998), this barrier imposed by the covering hinders the diffusion of gases and waters between the external environment and the seed.

Certainly, this behavior is linked to the particle size of the materials, which directly influences the pore size of the layers, making gas exchanges and imbibition difficult, both of which are very important to the germination process. According to Giménez (1997), materials that have smaller particles form smaller pores compared to materials that have larger particles. As the sand has a larger particle size, therefore, the sand coating will have a larger pore size compared to the calcium silicate and dolomitic limestone materials, and that facilitates gaseous exchange between the seeds and the external environment.

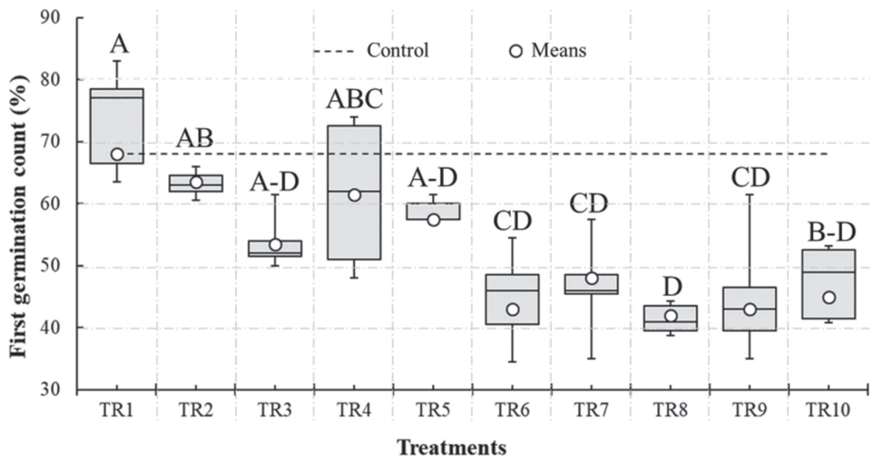

Figure 5: Box plot and Tukey test for first germination count (FGC) in *stylosanthes* cv. Campo Grande. Means followed by the same letter do not differ by Tukey's test at 5% probability.

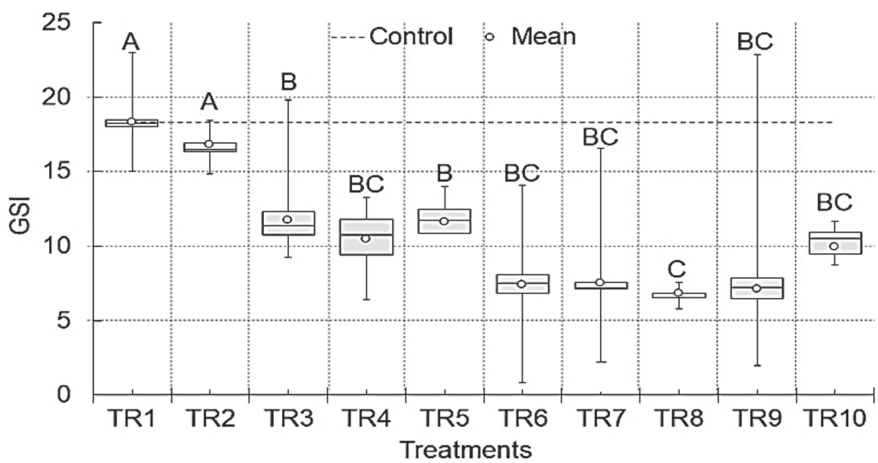

Figure 6: Box plot and Tukey test for Germination speed index (GSI) in *stylosanthes* cv. Campo Grande. Means followed by the same letter do not differ by Tukey's test at 5% probability.

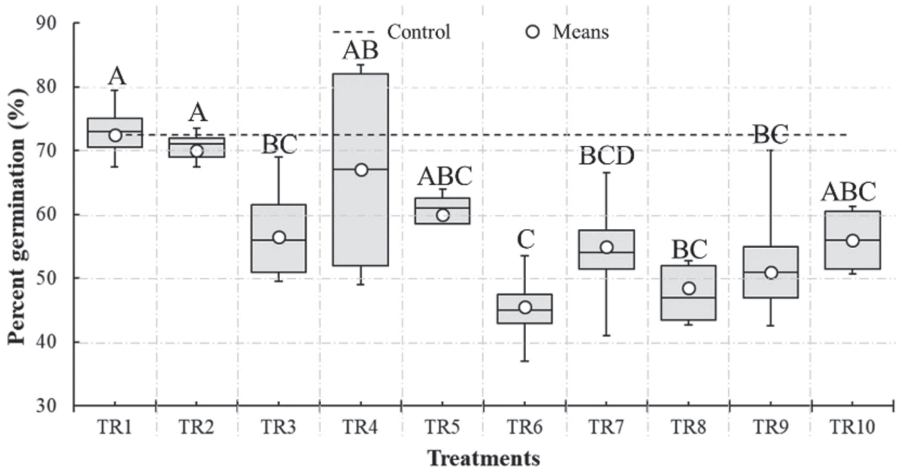

Figure 7: Box plot and Tukey test for Percent germination (%G) in *stylosanthes* cv. Campo Grande. Means followed by the same letter do not differ by Tukey's test at 5% probability.

Although coated seeds can reach final germination rate similar to uncoated seeds, this performance is absolutely related to vigour, so a non-standardized lot in this trait can promote inequality on the final germination percentage.

This effect becomes more evident when the seeds are coated with mixtures of sand, limestone or silicate. Oliveira *et al*. (2003) working with sand and limestone found a decrease in germination percentages of sweet pepper seeds. This delay in germination is a recurring problem in several studies (Silva & Nakagawa, 1998; Tunes *et al*., 2012; Caldeira *et al*. 2016; Acha *et al*., 2016; Sousa *et al*., 2016; Silva *et al*.., 2017; Xavier & Vieira, 2018; Acha *et al*., 2018). However, in spite of this delay, studies indicate that the process of coating seeds is a great alternative for maintaining their physiological characteristics (Medeiros *et al*. 2004; Brites *et al*., 2011; Sousa *et al*., 2017).

CONCLUSIONS

The physical characteristics, the weight of a thousand seeds (WTS), water content (SWC), maximum diameter (DMA), and minimum diameter (DMI) of the seeds *Stylosanthes capitata/macrocephala* cv. Campo Grande were been substantially modified.

Coating seeds with sand (0.25 mm) promotes the maintenance of physiological attributes, percentage (%G), germination velocity index (GSI), and first germination count (FGC) of *Stylosanthes capitata/macrocephala* cv. Campo Grande seeds.

Due to its inert characteristic, sand is a promising alternative for nutrient application via seeds.

REFERENCES

Acha AJ, Vieira HD & Freitas MSM (2016) Perennial soybean seeds coated with high doses of boron and zinc. African Journal of Biotechnology, 15:1998-2005.

Acha AJ, Vieira HD, Souza CLM & Silva FWA (2018) Methodology of applying different doses of boron and zinc in the coating of perennial soybean seeds. Journal of experimental agriculture international, 26:01-09.

AOSA - Association of Official Seed Analysts (2009) Seed vigour testing handbook. East Lansing, AOSA. 341p.

Bewley JD & Black M (1994) Seeds physiology of development and germination. New York, Plenum Press. 445p.

Brasil (2009) Ministério da agricultura. Regras para Análise de Sementes. Brasília, SNAD/DNDV/CLAV. 395p.

Brites FH, Silva Junior CA & Torres FE (2011) Germination of common, scarified and coated seed of different tropical forage species. Bioscience Journal, 27: 629-634.

Caldeira C, Carvalho M, Guimarães R & Coelho S (2016) Qualidade de sementes de tabaco durante o processo de pelotização e armazenamento. Ciência Rural, 46:216-220.

Carvalho NM & Nakagawa J (2012) Sementes: ciência, tecnologia e produção. Jaboticabal, FUNEP. 144p.

Conceição PM, Vieira HD, Silva RF & Campos SC (2009) Qualidade fisiológica e resistência do recobrimento de sementes de milho. Ciência e Agrotecnologia, 33:765-772.

Derré L, Custódio C, Agostini E & Guerra W (2013) Obtenção das curvas de embebição de sementes revestidas e não revestidas de *Urochloa brizantha* e *Urochloa ruziziensis*. Colloquium Agrariae, 9:103-111.

Embrapa - Empresa Brasileira de Pesquisa Agropecuária (1997) Centro Nacional de Pesquisa de Solos. Manual de métodos de análise de solo. Rio de Janeiro, Embrapa. 212p.

The R Project for Statistical Computing (2015) R: Uma linguagem e ambiente para computação estatística. Available at: <https://www.R-project.org/>. Accessed on: October 25th, 2019.

Fernandes C, Grof B, Chakraborty SB & Verzignassi JR (2005) Estilosantes Campo Grande in Brazil: a tropical forage legume success story. Tropical Grasslands 39:223-224.

Ferreira VF, Ferreira T, Carvalho R, Mavaieie D, Pereira D & Oliveira J (2015) Qualidade fisiológica de sementes revestidas de braquiária híbrida cv. Mulato II. Revista Agroambiente, 9:161-166.

Funguetto CI (2007) Tratamento de sementes de grandes culturas com micronutriente zinco, fungicida e polímero. Revista Norte Científico, 2:80-92.

Giménez D, Allmaras RR, Nater EA & Huggins DR (1997) Fractal Dimensions for Volume and Surface of Interaggregate Pores: Scale Effects. Geoderma, 77:19-38.

Guimarães CP, Vieira HD, Beltrame RA & Mussi-dias V (2020) Effects of calcium silicate on the protection of Brachiaria seeds against Sclerotium rolfsii. Revista de la Facultad de Ciencias Agrarias UNCuyo, 52:1853-8665.

Maguire JD (962) Speeds of germination-aid selection and evaluation for seedling emergence and vigor. Crop Science, 2:176-177.

Medeiros EM, Baudet L, Peres WB & Eicholz ED (2004) Modificações na condição física das sementes de cenoura em equipamento de recobrimento. Brazilian Journal of Seeds, 26:70-75.

Melo A, Seleguini A, Veloso V & Pereira M (2015) Recobrimento de sementes de tomate com concentrações crescentes de polímero sintético. Ciência Rural, 45:958-963.

Mendonça EAF, Carvalho NM & Ramos NP (2007) Revestimento de sementes de milho superdoce (Sh2). Brazilian Journal of Seeds, 29:68-79.

Oliveira JA, Pereira CE, Guimarães RM, Vieira AR & Silva JBC (2003) Performance of pepper seeds coated with different materials. Brazilian Journal of Seeds, 25:36-47.

Sampaio TG & Sampaio NV (2009) Recobrimento de sementes de hortaliças. In: Nascimento WM (Ed.) Tecnologia de sementes de hortaliças. Brasília, Embrapa Hortaliças. p.275-306, 2009.

Silva AD, Vespucci IL, Mata CR, Cruz S & Machado C (2016) Quality of soybean seeds subjected to increasing doses of super lime. Ciências Exatas e da Terra e Ciências Agrárias, 11:54-61.

Silva FWA, Vieira HD, Baroni DF, Maitan MQ & Acha AJ (2017) Germination Performance of Campo Grande (*Stylosanthes capitata/macrocephala*) Stylers Seeds Coated with Different Layers of Inert Material. Journal of Experimental Agriculture International, 18:01-08.

Silva JBC & Nakagawa J (1998) Metodologia para avaliação de resistência de péletes. Horticultura Brasileira, 16:151-158.

Sousa PGFD, Vieira HD & Acha AJ (2017) Coating with Different Doses of Fertilizer in Vinhatico Seeds. American Journal of Plant Sciences, 8:554-2568.

Sousa PGFD, Vieira HD, Amorim MM & Acha, AJ (2016) Coating with fungicide and different doses of fertilizer in vinhatico seeds. African Journal of Biotechnology 15:2091-2097.

Tao J, Zhang W, Liang L & Lei Z (2018) Effects of eco-friendly superabsorbent polymers on seed germination and seedling growth of maize. Royal Society Open Science, 5:171184.

Tunes LM, Pedroso DC, Tavares LC, Barbieri APP, Barros ACSA & Muniz MFB (2012) Tratamento de sementes de trigo com zinco: armazenabilidade, componentes do rendimento e teor do elemento nas sementes. Ciência Rural, 42:1141-1146.

Xavier PB & Vieira HD (2018) Physiological Potential of Seeds of Perennial Soybean cv. Comum Coated with Different Materials. American Journal of Plant Sciences, 09:01-12.

Xavier PB, Vieira HD & Guimarães CP (2015) Physiological potential of *Stylosanthes* cv. Campo Grande seeds coated with different materials. Journal of Seed Science, 37:117-124.