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CROP PRODUCTION

Potassium nitrate on overcoming dormancy in *Brachiaria humidicola* 'BRS Tupi' seeds

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ABSTRACT: *In this study, the aim was to determine the influence of potassium nitrate, using different concentrations and immersion times on the dormancy of the seeds of Brachiaria humidicola cv. 'BRS Tupi'. Four experiments were performed adopting a factorial scheme (5x3+1) in different seed lots, for different post-harvest storage durations, during which the seeds were immersed in potassium nitrate solutions of different specific concentrations (0, 0.1, 0.3, 0.5 and 1% KNO_3), for three exposure periods (12, 24 and 48h), plus one control (untreated), in a completely randomized design. The characteristics assessed included the imbibition curve, germination, first count and germination rate, as well as viability confirmed by using tetrazolium test. From the findings it was evident that treatments involving 0.1; 0.3; 0.5 and 1% KNO_3 or pure water, with a 12 hour-soaking period enabled the stored seeds to germinate well for a minimum of eight months post harvest. Root protrusion was observed 24 hours post seed imbibition, whereas for the untreated seeds, satisfactory germination was observed from at least 12 months post harvest and, in most of the lots, between 18 and 24 months.*
Key words: *germination, forage, chemical treatment.*

O potássio na superação da dormência em sementes de *Brachiaria humidicola* 'BRS Tupi'

RESUMO: *Objetivou-se avaliar os efeitos do nitrato de potássio, em diferentes concentrações e períodos de imersão, na superação da dormência de sementes de Brachiaria humidicola cv. 'BRS Tupi'. Os experimentos, em número de quatro, foram realizados com diferentes lotes de sementes, em esquema fatorial (5x3+1) em diferentes períodos de armazenamento após a colheita, em que os tratamentos consistiram de imersão das sementes em soluções com diferentes concentrações de nitrato de potássio (0; 0,1; 0,3; 0,5 e 1% de KNO_3), por três períodos de exposição (12, 24 e 48h), mais uma testemunha (sem tratamento), em delineamento inteiramente casualisado. As características avaliadas foram: curva de embebição, germinação, primeira contagem e índice de velocidade de germinação e viabilidade pelo teste de tetrazólio. Os tratamentos 0,1; 0,3; 0,5 e 1% de KNO_3 ou água pura, com período de embebição por 12 horas, proporcionam germinação satisfatória das sementes armazenadas por, no mínimo, oito meses após a colheita. A partir de 24h de embebição das sementes ocorre protrusão radicular, enquanto para as sementes não tratadas a germinação satisfatória ocorre, no mínimo, a partir de 12 meses da colheita e, na maioria dos lotes, de 18 a 24 meses.*
Palavras-chave: *germinação, forrageira, tratamento químico.*

INTRODUCTION

Brazil, which began to intensify the production of tropical forage seeds from the 1970s onwards, has now become the world's greatest producer, consumer and exporter. Having an annual turnover of more than 100 thousand tons, Brazil exports around 10% of the seeds it produces to more than 16 countries (VERZIGNASSI, 2010).

However, dormancy is one of the factors adversely affecting the tropical forage seeds, as it results in slow pasture establishment. This triggers an escalation in the production cost, delays and introduction of animals which predisposes to their degradation (TEIXEIRA & VERZIGNASSI, 2010). However, there is still a lack sufficient clarity regarding this dormancy imposed on the seeds of most brachiaria, in terms of its characteristics, potency and persistence over time. Besides, it must be emphasized that the efficiency of the methods employed to overcome dormancy varies, depending on several factors (LACERDA et al., 2010).

Many treatments have been reportedly tried to suppress dormancy in the *Brachiaria* seeds; however, controversy continues to prevail over the methods employed. A few authors have recommended, for instance, chiseling using sulfuric acid - H_2SO_4 (OLIVEIRA et al., 2008). Findings of

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the current study revealed that chemical scarification may not significantly improve the germination and could rather even damage the seeds, rendering this an impractical option (COSTA et al., 2011; VERZIGNASSI et al., 2013a).

In the literature, to overcome the seed dormancy of *Brachiaria humidicola* cv. 'BRS Tupi', one study refers to the use of sulfuric acid, which while it facilitates overcoming dormancy, reduces the viability (VERZIGNASSI et al., 2013a). However, the storage of 'BRS Tupi' seeds in the production area is also important for the storage, which is determinant in overcoming dormancy, but varies according to the lot (VERZIGNASSI et al., 2013b; MOREIRA, 2014). After degranulation and for periods up to 108 days post harvest in the bunch, it was not effective in overcoming dormancy (VERZIGNASSI et al., 2013c).

Other treatments that were attempted to overcome the dormancy of the 'BRS Tupi' seeds included using ethylene (0.3%), which was ineffective (VERZIGNASSI et al., 2013d); however, the application of potassium nitrate solution, 2%) to the germination substrate was reported to be very popular as a testing technique employed in the standard germination to overcome dormancy of the species in the laboratory, in which the entry of oxygen impedes germination (BRASIL, 2009).

In this context, the present research aimed to assess the effects of potassium nitrate, using different concentrations and immersion periods in overcoming seed dormancy of *Brachiaria humidicola* cv. 'BRS Tupi'.

MATERIALS AND METHODS

In the Embrapa Cattle Seed Technology Laboratory, in Campo Grande - MS, between October 2013 and February 2015, the soaking curve of the *B. humidicola* 'BRS Tupi' seeds and three experiments to identify the best method of overcoming dormancy of the seeds from the different 'BRS Tupi' cultivars harvested from the panicle, from different production sites were recorded.

In experiment 1, when the seed dormancy was at its highest, potassium nitrate was added in different concentrations (0.0 (distilled water), 0.1, 0.3, 0.5 and 1%) for different exposure times (12 months, 24 and 48 hours), using seeds from the E1 lot (nine months post harvest), raised in Campo Grande - MS (harvest 2012/2013) and harvested in January 2013. Evaluations were done immediately post treatments.

In experiment 2, potassium nitrate in different concentrations (0.0 (distilled water), 0.1, 0.3, 0.5 and 1%) were used to evaluate the effect of seed storage and exposure periods (12 months, 24 and 48 hours) utilizing seeds from the E2 plot (five months post harvest), produced in Campo Grande - MS (harvest 2013/2014), harvested during the final week of December 2013. Evaluations were done immediately after the treatments.

Potassium nitrate in different concentrations (0.0 (distilled water), 0.1, 0.3, 0.5 and 1%) and exposure times (12, 24 and 48h) were employed for experiment 3, as well using seed from lot B, produced in Rondonópolis - MT (crop 2013/2014) and harvested in February 2014. Some amount of the seeds were treated four months post harvest and evaluated immediately post treatments (t1); whereas another quantity was treated at six months post harvest, with evaluation being done immediately, at four months and six months post treatment (t2).

The experiment involved the usage of potassium nitrate in four different concentrations (0.0 (distilled water), 0.1, 0.3, 0.5 and 1%) and three exposure times (12, 24 and 48h). Batch S seeds, from Bandeirantes - MS (crop 2013/2014), harvested in the final week of December 2013, was treated eight months post harvest and evaluated immediately at four and six months post treatments. Pure seeds were obtained according to the method prescribed in the Rules for Seed Analysis - RAS (BRASIL, 2009).

To determine the imbibition curve of the seeds in three of the lots evaluated, 16 replicates of 50 seeds from each batch were used. Using a precision analytical balance the initial weights of the seeds were recorded. They were then placed in acrylic Petri dishes on two germitest paper towels moistened with distilled water equivalent to 2.5 times the dry weight of the substrate. Plates were maintained at 25°C in a Biochemical Oxygen Demand (BOD) type germination chamber in total darkness, and their weights were recorded after 1, 3, 7, 12, 24 and 48 hours of plating; when at least one seed from any plate produced a primary root, the imbibition was quantified in grams by the weight recorded in each evaluation.

Treatments involved different solutions of potassium nitrate (KNO_3, p.a.) and exposure periods using a dark plastic container at room temperature (25-28°C) and a control (untreated seeds) stored under identical conditions. Thus, experiments were performed following a factorial arrangement (5x3+1), in a completely randomized design, with a total of 16 treatments for each experiment.

After each immersion period the seeds were promptly water-washed in running water,

paper dried on absorbent sheets and tested using the standard germination test. Seeds were grown in transparent acrylic boxes (11 × 11 × 3cm, gerbox) on two leaves of paper knocks to which distilled water 2.5 times the weight of the paper in water was added (Brazil, 2009). For each treatment 100 seeds were used. Boxes in the germinator were conditioned using alternating temperature and light conditions (15°C for 16 hours and 35°C for 8 hours). Results were shown as the summative (cumulative) evaluations performed everyday for 21 days. Tolerance analysis according to RAS was performed for all the results (BRAZIL, 2009). The seeds left over from the treatments were stored in paper envelopes at room temperature (uncontrolled) between 25-28°C for evaluations in the future.

The findings from the standard germination test were used to determine the germination speed index (GI) and first germination count (GPC). The maximum permissible variation tolerance level among the repetition results was applied. To calculate the IVG, the formula according to MAGUIRE (1962) was used.

IVG = G1 / N1 + G2 / N2 + ... + Gn / Nn

Where G1, G2 and Gn represented the number of normal seeds germinated up to the last evaluation day and N1, N2 and Nn represent the number of days in which germination G1, G2 and Gn were evaluated. Tetrazolium test was performed with a sample of 110 pure seeds for each treatment, which were preconditioned for 24 hours in water and then sectioned using a razor blade. Later, they were soaked in tetrazolium solution (0.5%) for 4 hours at 30ºC, analyzed and classified under normal and abnormal seeds, according to RAS (BRAZIL, 2009).

In the first evaluation the water content was determined by the greenhouse method at 130-133°C for one hour (BRASIL, 2009); five replications using 10g of seeds from each batch were performed and the findings were expressed in percentage.

Data analysis was done using the ASSISTAT 7.7 beta software (SILVA & AZEVEDO, 2009) to analyze the variance and compare the means by Tukey's test, at 5% probability; the data were transformed when necessary (transformations reported in the footers).

RESULTS AND DISCUSSION

At first, all the seeds were observed to have approximately 8% water content. The seed imbibition curves of lots B, S and E1 revealed that the intense and quick water uptake was seen between 1 and 3 hours, with respect to the initial seed weight, implying the first imbibition phase described by CARVALHO & NAKAGAWA (2000). After 48h of imbibition, the seeds from the lots evaluated reached the third stage when the radicle protrusion commenced, as described by MARCOS FILHO (2005).

These data clearly revealed the absence of resistance to the water flow into the cv. 'BRS Tupi' seeds, due to mechanical restriction; this implies that the state of dormancy is not linked with the integumental permeability to water. Identical findings were reported by CÂMARA & STACCIARINI-SERAPHIN (2002) when realizing the imbibition curve of *B. brizantha* cv. 'Marandu'.

In experiment 1, using the potassium nitrate tests, the treatments performed in lot E1 at nine months post harvest showed a positive influence of overcoming the dormancy of the seeds in comparison to the control. The highest germination percentages were recorded with treatments of 0.3; 0.5 and 1% concentration for 48h, while the water treatment revealed the lowest germination values for the same batch (Table 1).

The positive results observed in the treatments with potassium nitrate imply that the reason for the dormancy of the *Brachiaria* seeds of the cultivar 'BRS Tupi' was the restriction of the exchanges of gases, because the nitrate overcomes such dormancy by its action in the Pentose phosphate pathway (CARVALHO & NAKAGAWA, 2000).

In experiment 2, using the lot E2 seeds, treated five months post harvest, no dormancy over the control was noted. This produced germination of 1% maximum (Table 1), indicating the need for storage periods above five months for the treatments to be effective.

The highest germination rates (IVG) for the seeds of lot E1 were reported in the same treatments, recording the highest total germination; whereas for the lot E2 seeds, the IVG values were very low, not more than 0.05 (Table 1).

Regarding the first germination count (GPC), values similar to those of the germination and IVG were reported, in which the seeds of the E1 lot revealed no effect of the treatments on the viability; however, for the lot E2 seeds, the treatments of the immersion in potassium nitrate for the 48 h negatively affected the viability, resulting in a decrease of up to 64% (Table 1).

In experiment 3 using the lot B seeds, treated four months post harvest (t1), the dormancy did not exceed when compared with the control

Table 1 - Germination, germination speed index (IVG), first germination count (PCG) and viability (tetrazolium test) of the E1 and E2 lots of *B. humidicola* cv. 'BRS Tupi' (Experiments 1 and 2, respectively). Evaluations were done immediately post each treatment. Campo Grande, 2013.

Lot E1												
KNO_3 (%)	--------Germination (%)--------			----------IVG----------			----------PCG[2]----------			----Tetrazolium (%)---		
	Exposure times (h)			Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12		48	12	24	48	12	24	48	12	24	48
0	20.3cB[1]	21.0dB	30.8cA	1.9cB	2.1dB	3.8cA	5.6bAB	2.6bB	13.3bA	70.9	72.2	69.2
0.1	33.3bC	46.3cB	71.4bA	3.3bC	5.4cB	8.7bA	11.5abA	19.5aA	22.9bA	75.7	81.4	72.2
0.3	39.1bC	58.1bB	79.4abA	3.9bC	6.8bB	9.7abA	12.3abB	22.4aAB	30.5abA	74.3	71.0	73.2
0.5	55.8aC	62.9bB	79.5abA	5.4aC	7.6bB	10.3aA	9.8abB	26.9aA	40.3aA	74.1	74.3	75.9
1	55.0aC	76.7aB	84.3aA	5.6aB	8.9aA	9.1bA	24.5aA	29.5aA	21.8bA	72.7	83.3	71.8
CV (%)		11.8			15.3			38.0			-	
Control		1.25**			0.09**			0.00**			70.19	
Lot E2												
KNO_3 (%)	---------Germination (%)[2]--------			----------IVG[3]----------			----------PCG[2]----------			----Tetrazolium (%)-----		
	Exposure times (h)			Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48	12	24	48
0	0.6Aa[1]	0.5aA	0.8aA	0.04aA	0.05aA	0.05aA	0.0	0.3	0.0	77.4	73.1	75.0
0.1	0.1aA	0.3aA	0.1aA	0.00aA	0.02aA	0.00aA	0.0	0.1	0.0	70.4	73.7	32.3
0.3	0.3aA	0.3aA	0.4aA	0.02aA	0.01aA	0.02aA	0.0	0.0	0.0	71.4	73.9	19.1
0.5	0.3aA	0.0aA	0.1aA	0.01aA	0.00aA	0.02aA	0.0	0.0	0.0	65.8	68.6	22.3
1	0.5aA	0.3aA	0.3aA	0.03aA	0.03aA	0.03aA	0.0	0.0	0.1	66.4	69.5	14.5
CV (%)		29.9			4.1			12.2			-	
Control		0.3[NS]			0.01[NS]			0.0[NS]			78.5	

[1]Values followed by the same capital letter in the rows and by lower case in the columns do not differ from each other by the Tukey test at 5% probability. Means of eight replicates, utilizing 100 seeds each. [2]Arcsen transformed data ((X+0.5) / 100) [1/2]original averages are shown. Transformed data (X+0.5) [1/2]of original averages were presented. [**]Significance observed at the level of 1% probability with respect to the treatments. [NS]No significance observed in relation to the treatments.

(Table 2); 10% maximum germination and 0.6 maximum IVG were recorded for the treatment with 12-hour immersion in a 0.3% potassium nitrate concentration. Seven days post the germination test (PCG), none of the seeds had germinated and the treatments did not affect their viability (Table 2).

Dormancy of the *B. humidicola* cv. 'Humidicola' seeds was overcome after 21 storage months. It was unaffected by acid scarification or any kind of treatment using germination-promoting substances prior to that period (COSTA et al., 2011). Similarly, storage was identified as the determinant to overcome the seed dormancy in three *B. humidicola* 'BRS Tupi' lots. Variations were observed depending on the unique characteristics of each one, and satisfactory values (germination greater than 50%) were achieved from seven to twelve months of storage (VERZIGNASSI et al., 2013a). However, MOREIRA (2014) confirmed that a 12-month storage period of the *B. humidicola* cv. 'BRS Tupi' seeds was not effective in overcoming the dormancy, revealing less than 18% of germination.

In the experiment on analyzing three seeds from lot B, which had been subjected to treatments six months post harvest (t2), none of the treatments employed were effective in overcoming dormancy (Table 3). After these treated seeds were stored for ten and twelve months post harvest, they were analyzed. A germination percentage of 30% was recorded, identical to the control. The germination rate increased over time and achieved a maximum of 3.77 for the treatment involving 24 hours of soaking time in 0.3% concentration of potassium nitrate.

The low germination percentage reported, in spite of the high viability (above 70%), could be linked to the low vigor with respect to the other lots evaluated or secondary dormancy, which results from unfavorable environmental conditions after separation from the parent plant, such as very high temperatures (CARVALHO & NAKAGAWA 2000).

Table 2 - Germination, germination speed index (IVG), first germination count (PCG) and viability (tetrazolium test) of *B. humidicola* cv. 'BRS Tupi' lot B (t1) (Experiment 3), undergoing treatment four months post harvest.

KNO_3 (%)	-------Germination (%)[2]-------			----------IVG[3]----------			----------PCG (%)----------			--------Tetrazolium (%)--------		
	-----Exposure times (h) ----			-----Exposure times (h)-----			---Exposure times (h)-----			------Exposure times (h)----		
	12	24	48	12	24	48	12	24	48	12	24	48
0	2.1bA[1]	2.3cA	1.6bA	0.1bA	0.1cA	0.1bA	0.0	0.0	0.0	72.8	72.3	66.1
0.1	8.8aA	5.3bAB	5.0aB	0.5aA	0.3bB	0.3aB	0.0	0.0	0.0	71.9	78.8	70.5
0.3	5.5aB	10.1aA	2.3abC	0.3aB	0.6aA	0.1abC	0.0	0.0	0.0	72.9	71.8	72.7
0.5	2.4bAB	3.6bcA	1.3bB	0.1bA	0.2bcA	0.1bA	0.0	0.0	0.0	69.4	67.7	71.7
1	2.0bA	2.8bcA	2.7abA	0.1bA	0.2bcA	0.1bA	0.0	0.0	0.0	68.4	72.1	67.7
CV(%)		27.5			8.2			-			-	
Control		1.1**			0.05**			0.0			-	

[1]Values followed by the same capital letter in the rows and by lower case in the columns do not differ from each other by the Tukey test at 5% probability. Means of eight replicates utilizing 100 seeds each. [2]Arcsen transformed data ((X+0.5) / 100) $^{1/2}$original averages are shown. [3]Transformed data (X+0.5) $^{1/2}$ of original averages were presented. **Significance observed at the level of 1% probability with respect to the treatments.

Treatments employing potassium nitrate for 48 hours decreased the seed viability by 42% in comparison to the control, concurring with the findings of VIEIRA et al. (1998) who also reported the deleterious effects of high potassium nitrate concentrations (more than 0.5mol m^{-3}) on the germination of *B. brizantha* cv. 'Marandu' dormant seeds.

In the experiment using four seeds that had been subjected to eight months' storage post harvest (lot S), the treatment involving 12-hour immersion in water effectively overcame the dormancy at satisfactory levels (germination> 50%) (Table 4). The different KNO3 concentrations during the same immersion period also revealed aggregate values; however, immersing them again for 48 hours in KNO_3 harmed the seed viability. In their research using 0.2% potassium nitrate solution, WISINTAINER et al. (2010) reported nil efficiency in overcoming seed dormancy in *B. ruziziensis* when compared with the seeds immersed in H_2SO_4 for five to ten minutes.

The most likely reason for the harmful effect on the seeds is the high concentration of the soluble salts, which raises the osmotic pressure; this ensures that little or no water is absorbed, causing seed dehydration; in the more extreme cases, the seeds in which the germination had been initiated, cell dehydration and seedling death were observed (PRISCO & O'LEARY, 1970). Decreased seed viability observed in the treatment involving 48 hours of exposure (Table 3) was completely linked to the commencement of root protrusion, which took place at 48h of imbibition, as determined by the imbibition curve.

The finding that the distilled water treatment alone facilitated overcoming the dormancy was perhaps due to the leaching of the germination-inhibiting substances present in the seed coats. These water-soluble substances or the physiological conditioning of the seeds due to the effect of the water were the likely reasons.

In the lot S seeds, germination was observed to increase over time, almost completely overcoming the dormancy, both for the control (untreated seeds) and other treatments at 12 months post harvest. The viability values, according to the tetrazolium test, were close similarity to those of the germination.

The highest germination speed rates were evident in the evaluations of December/ 2014 and February/2015 with respect to the first evaluation, particularly for the 12-hour immersion treatment. However, it decreased when the seeds were immersed for 48 hours in KNO_3, revealing a drop in the seed viability. BOTOTTI et al. (2014) in their study on the pre-germination treatments of *B. brizantha* cv. 'MG-5' reported a rise in the germination speed after 3 to 4h of pre-soaking in KNO3 solution (0.2%).

Among the seeds from the four lots, the seed viability from three lots was negatively altered by at least one treatment with potassium nitrate; this raises some concern when it is to be implemented on an industrial scale by the productive sector, because the seeds of forages have no purity, which can be either

Table 3 - Germination, germination speed index (IVG), first germination count (PCG) and viability (tetrazolium test) of *B. humidicola* cv. 'BRS Tupi' seeds of Lot B (t2) (Experiment 3), submitted to treatment six months post harvest. Evaluations performed immediately (0MAT), four (4MAT) and six months post treatments, respectively (6MAT). Campo Grande, 2015.

----------Germination (%)----------									
	----------aug/14 (0 MAT)----------			----------dec/14 (4 MAT) ----------			----------feb/15 (6 MAT) ----------		
KNO_3 (%)	Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48
0	5.4cA[1]	1.8dA	2.5bA	15.3bA	18.3abA	14.0aA	24.3aA	27.8abA	31.5aA
0.1	10.1bcAB	15.4bcA	5.1bB	16.3bA	16.7abA	13.3aA	27.3aA	19.5bA	22.0bA
0.3	15.3bB	21.5abA	5.9bC	17.3bA	11.5bA	13.0aA	29.5aA	35.0aA	18.8bB
0.5	30.5aA	25.0aB	13.8aC	16.3bA	14.0abAB	9.3aB	29.0aA	21.0bAB	16.8bB
1	29.8aA	10.3cB	5.9bB	25.0aA	19.3aA	13.0aB	31.3aA	24.8bAB	17.5bB
CV (%)		35,29			23,89			18,44	
Control		5,25**			6,25**			31,00*	
----------Germination speed index----------									
	----------aug/14 (0 MAT)----------			----------dec/14 (4 MAT) ----------			----------feb/15 (6 MAT)----------		
KNO_3 (%)	Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48
0	0.4cA	1.2dA	0.2bA	2.0aA	1.7aA	1.4aA	2.3aA	2.6bA	3.2aA
0.1	0.8bcB	1.7bcA	0.4abB	2.1aA	1.6aA	1.5aA	2.6aA	1.9bA	2.2abA
0.3	1.3bB	2.0abA	0.5abC	1.7aA	1.2aA	1.5aA	2.9aAB	3.8aA	2.2abB
0.5	3.5aA	2.4aB	1.0aC	1.6aA	1.3aA	0.9aA	2.9aA	1.9bB	1.7bB
1	2.9aA	1.2cB	0.5abC	2.2aA	1.7aA	1.2aA	3.0aA	2.6bAB	1.9bB
CV (%)		41.3			28.2			20.8	
Control		0.52**			0.67**			3.18*	
----------First germination count (%)----------									
	----------aug/14[2] (0 MAT)----------			----------dec/14[2] (4 MAT) ----------			----------feb/15[2] (6 MAT) ----------		
KNO_3 (%)	Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48
0	0.0cA	0.6bA	0.1aA	8.3aA	2.5aB	2.5abB	4.0aA	5.5abA	6.5aA
0,1	0.4cB	6.5aA	0.4aB	7.8aA	1.7aB	3.8aAB	3.3aA	4.0abA	4.0aA
0,3	2.5cA	3.8aA	1.8aA	4.3abA	2.0aA	4.0aA	6.3aA	8.8aA	7.5aA
0,5	15.5aA	5.6aB	0.1aC	5.3abA	1.8aB	1.0abB	3.3aA	1.8bA	4.0aA
1	6.8bA	4.4aA	0.1aB	2.8bA	2.0aA	0.5bA	3.5aA	8.0abA	4.8aA
CV (%)		42.5			28.3			33.9	
Control		1.9[NS]			1.8[NS]			7.0	
----------Tetrazolium (%)----------									
	----------jan/15----------								
KNO_3 (%)	Exposure times (h)								
	12			24			48		
0	79.1			73.7			67.9		
0,1	75.2			67.9			41.1		
0,3	72.7			74.0			41.1		
0,5	82.4			56.5			47.8		
1	71.3			68.0			30.9		
Control	72.8								

[1]Values followed by the same capital letter in the rows and by lower case in the columns do not differ from each other by the Tukey test at 5% probability. Averages of eight replicates of 100 seeds each in Aug / 2014 and averages of four replicates of 100 seeds each in Dec/2014 and Feb/15.. Arcsen transformed data ((X+0.5)/100) $^{1/2}$ original averages are shown. [3]Transformed data (X+0.5) $^{1/2}$of original averages were presented. **Significance observed at the level of 1% probability with respect to the treatments. *Significance observed at the level of 5% probability with respect to the treatments. [NS]No significance observed in relation to the treatments.

inefficient or excessive, and deleterious, causing the physiological quality of the seeds to be compromised.

CONCLUSION

The potassium nitrate (KNO_3) solutions in concentrations of 0.1; 0.3; 0.5 and 1% or distilled water, with a 12-hour soaking period induced satisfactory germination of the stored *Brachiaria humidicola* seeds for at least eight months post harvest. Germination of the untreated seed was satisfactory until a minimum of 12 months post harvest and, in most lots, between 18 and 24 months.

Table 4 - Germination, germination speed index (IVG), first germination count (PCG) and viability (tetrazolium test) of the *B. humidicola* cv. 'BRS Tupi' Lot S (Experiment 4), submitted to treatment eight months post harvest. Evaluations performed immediately (0MAT), four (4MAT) and six months post treatments (6MAT). Campo Grande, 2015.

Germination (%)									
	aug/14 (0 MAT)			dec/14 (4 MAT)			feb/15 (6 MAT)		
KNO_3(%)	Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48
0	61.5aA[1]	28.4bB	9.8aC	66.0bA	64.0bA	59.7aA	78.0aA	69.8abB	72.8aAB
0.1	32.4cA	17.5cB	5.5aC	71.0abA	63.8bB	24.0bC	74.0aA	68.3abA	24.5bB
0.3	45.3bA	16.5cB	4.3aC	66.8abA	69.5abA	18.5bB	78.8aA	65.0bcB	17.3bC
0.5	49.1bA	54.6aA	7.5aB	70.8abA	75.3aA	19.8bB	76.8aA	73.8aA	22.3bB
1	46.0bA	9.4dB	4.4aB	73.8aA	67.5bA	23.0bB	65.3bA	58.8cA	22.0bB
CV (%)		20.4			6.9			7.2	
Control		5.0**			27.3**			62.8*	
Germination speed index									
	aug/14 (0 MAT)			dec/14 (4 MAT)			feb/15 (6 MAT)		
KNO_3(%)	Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48
0	5.5aA[1]	2.6bB	0.9aC	10.3aA	7.9aB	7.2aB	10.1aA	7.6aB	8.2aB
0.1	3.0bA	1.8bcB	0.4aC	11.0aA	7.8aB	2.9bC	7.9bA	7.4abA	3.0bB
0.3	5.4aA	1.4cB	0.5aC	10.4aA	6.6aB	2.5bC	8.7bA	7.1abB	2.0bC
0.5	5.3aA	5.5aA	0.6aB	10.7aA	7.2aB	3.0bC	9.9aA	7.9aB	2.6bC
1	5.5aA	1.0cB	0.4aB	11.0aA	7.0aB	3.1bC	8.4bA	6.4bB	2.4bC
CV (%)		31.9**			11.3**			8.4	
Control		0.5			2.5			6.6*	
First germination count (%)									
	aug/14[2] (0 MAT)			dec/14[2] (4 MAT)			feb/15[2] (6 MAT)		
KNO_3(%)	Exposure times (h)			Exposure times (h)			Exposure times (h)		
	12	24	48	12	24	48	12	24	48
0	2.1cA[1]	4.7abA	0.8aA	54.7aA	28.3aB	24.0aB	27.5aA	33.3aA	20.3aA
0.1	4.7bcA	3.3abA	0.8aA	57.0aA	30.0aB	10.5aC	2.8bB	33.3aA	8.0abB
0.3	18.4aA	1.6bB	1.5aB	52.8aA	11.0bB	9.5aB	1.3bB	22.8aA	7.3abB
0.5	9.9abA	12.0aA	1.0aB	47.0aA	4.8bB	12.0aB	32.3aA	34.3aA	4.8bB
1	8.4bcA	4.0abAB	1.0aB	45.8aA	13.3bB	12.8aB	30.5aA	23.0aA	3.3bB
CV (%)		55.3			27.1			26.8	
Control		1.4NS			3.5**			10.5*	
Tetrazolium (%)									
	jan/15								
KNO_3(%)	Exposure times (h)								
	12			24			48		
0	78.1			70.4			69.6		
0.1	81.3			82.6			25.5		
0.3	73.9			71.7			23.6		
0.5	75.2			84.2			15.0		
1	77.6			66.7			22.2		
Control	80.4								

[1]Values followed by the same capital letter in the rows and by lower case in the columns do not differ from each other by the Tukey test at 5% probability. Averages of eight replicates of 100 seeds each in Aug/2014 and averages of four replicates of 100 seeds each in Dec/2014 and Feb/15. [2]Arcsen transformed data $((X+0.5)/100)^{1/2}$ original averages are shown. [3]Transformed data $(X + 0.5)^{1/2}$ of original averages were presented. ** Significance observed at the level of 1% probability with respect to the treatments. *Significance observed at the level of 5% probability with respect to the treatments. [NS]No significance observed in relation to treatments

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