OSMOCONDITIONING OF *Urochloa brizantha* SEEDS TO REDUCE PELLETING NEGATIVE EFFECTS

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ABSTRACT

This study aimed at evaluating the influence of different pelleting materials on the physiological quality of *Urochloa brizantha* seeds and using osmopriming to reduce possible negative effects of pelleting. The experiment was developed using three levels of seed physiological quality (high, medium and low percentage of germination), treated or not treated with KNO_3, to -1.1 MPa for 12 hours. After being washed and dried, the seeds were covered with two types of materials, a composite of sand and microcellulose and another consisting of sand, microcellulose and Explosol®. *U. brizantha* seed coating affected negatively the germination final percentage, root protrusion speed index, speed of emergence index and seedling emergence. Osmopriming is effective in minimizing the negative effects of pelleting, mainly in physiological medium quality seeds.

Keywords: Potassium nitrate, priming, physiological quality, coating

REDUÇÃO DOS EFEITOS NEGATIVOS DA PELETIZAÇÃO EM SEMENTES DE U*rochloa brizantha* POR CONDICIONAMENTO OSMÓTICO

RESUMO

Objetivou-se neste trabalho verificar a influência de materiais de peletização na qualidade fisiológica de sementes de *Urochloa brizantha* e avaliar o efeito do condicionamento osmótico no envigoramento das sementes, visando a reduzir possíveis efeitos negativos da peletização. O ensaio foi conduzido utilizando sementes com três níveis de qualidade fisiológica (alta, média e baixa porcentagem de germinação), submetidas ou não ao condicionamento osmótico com KNO_3, a -1,1 MPa, por 12 horas. Após lavagem e secagem, as sementes foram peletizadas com dois tipos de material, um composto de areia e microcelulose e outro constituído de areia, microcelulose e Explosol®. A peletização de sementes de *U. brizantha* afeta negativamente a porcentagem de germinação, o índice de velocidade de protrusão radicular, a emergência e a velocidade de emergência de plântulas. O condicionamento fisiológico é eficiente em minimizar os efeitos negativos da peletização, principalmente em sementes de média qualidade fisiológica.

Palavras-chave: Nitrato de potássio, priming, qualidade fisiológica, revestimento

INTRODUCTION

Brazil outstands as the greatest producer and exporter of tropical forage seeds in the world, generating millions of dollars in business annually and creating thousands of jobs in the country (DEMINICIS et al., 2010; PEREIRA et al., 2011). Among the tropical forage species grown in Brazil, the *Urochloa brizantha,* cultivar Marandu is the most planted and commercialized in the domestic market and the main exported cultivar (ARAÚJO et al., 2008; GASPAR-OLIVEIRA et al., 2008). Such interest in this species is due to its hardness, competitiveness and capability to develop in diverse environments, with important characteristics such as high production of dry mass and fast sprouting after grazing (ZANUZO et al., 2010).

As most of the tropical forage species, *U. brizantha* also has factors which hamper the high quality seed production such as: lack of uniformity in the inflorescence emission, irregular blooming in the panicles; low number of fertile seeds; high natural dehiscence and seed dormancy, a physiological phenomenon that hampers uniform distribution of populations and favors the appearance of invading plants in the pasture (BONOME et al., 2006).

In Brazil, the prevailing system of planting is the broadcast seeding since the *U. brizantha* seeds present characteristics that make the mechanical sowing difficult such as: small and non-uniform size and shape, in addition to the presence of impurities, which are hard to separate. This sowing method demands high seed density for the success of the establishment of the pasture, raising costs with the crop implementation.

Aiming at reducing the cost with seeds and improve the efficiency of sowing, the pelleting seed technique was developed, which consists in deposing dry, inert material and cementing material (adhesive) on the surface of the seed, allowing the modification or not of its shape and size (LOPES & NASCIMENTO, 2012). The use of pelleted seeds enables the reduction in the pasture implementation costs, reducing the consumption of seeds, allowing sowing mechanization, providing the seeds with better sanity and establishment of seedlings through the incorporation of nutrients, growth regulators and other fertilizers (ALBUQUERQUE et al., 2010; SANTOS, 2016).

However, *U. brizantha* cv. Marandu seed pelleting has been seen to reduce the germination and seedling emergence speed (SANTOS et al., 2010; SANTOS et al., 2011), as well as effects that were observed with other species of agricultural interest such as *Zea mays* and *Daucus carota* (CONCEIÇÃO & VIEIRA, 2008; NASCIMENTO et al., 2009).

The use of seeds with high physiological quality is vital for the success of economic interest crops, since it enables suitable emergence in the field, along with strong and uniform plants. In this sense, the use of osmopriming aims at improving the performance of seeds in the field. After this treatment, Bonome et al. (2006) observed an increase in the strength of the germination process, when the *U. brizantha* cv. Marandu seeds were immersed in KNO_3 solution with -1,1 and -1,4MPa osmotic potential for 12 hours.

This study aimed at verifying the influence of several pelleting materials in the physiological quality of *U. brizantha* seeds and evaluating the effect of osmoconditioning to mitigate pelleting negative effects.

MATERIAL AND METHODS

The seeds used came from three different *Urochloa brizantha* seed lots of the Marandu cultivar with different levels of physiological quality (low, medium and high). Two of them were acquired from the company *Na Terra* and another from the company *Matsuda*. The experiments were carried out in the laboratory of seed analysis at the Federal University of Lavras, Lavras, Minas Gerais, Brazil. Initially, the seeds were processed using ventilation (blower) and, later on, manually selected, aiming at excluding flat and malformed seeds and impurities. The percentage of seed germination was 26%; 64% and 76% for the low, medium and high physiological quality lots, respectively. The low physiological quality lot had been stored for over two years and presented germination percentage below the minimum set for commercialization.

Seeds from each lot were submitted or not to osmopriming in a KNO_3, a -1,1 Mpa solution, for 12 hours, under immersion with aeration (BONOME et al., 2006), washed in running water for 5 minutes to eliminate the solution residue and, later on, dried at room temperature for 24 hours until they reached the initial humidity degree of 11%.

After dried, the seeds were divided into three portions: the first was pelleted with a composite of sand + microcellulose in a 2:1 ratio (S+M); the second with sand + microcellulose + Explosol® in a 4:2:1 ratio (S+M+E), while the third portion was not pelleted (control). A polyvinyl acetate based glue (PVA), brand Cascolax was used as adhesive, diluted at 20%. The pelleting was carried out in a concrete mixer, where the seeds were revolved around its own axle, receiving the filling ingredients and cementing agent (adhesive) gradually until they adhere to the seed surface in successive layers and the seeds reach the desired size. The pellet was selected in a sieve number 10 in order to give the seeds an uniform size. The pelleted seeds remained on the laboratory bench for 24 hours at 25 °C to dry.

The seed physiological quality was evaluated using germination tests, root protrusion speed index (RPSI), seedling emergence and seedling emergence speed index.

The germination tests and RPSI were carried out simultaneously, in transparent plastic boxes (11,5cm x 11,5cm x 3,5 cm), with four replications of 50 seeds for each treatment, distributed on two sheets of blotting paper, damped with water whose amount corresponded to 2.5 mass of the dry substrate. The temperature used was 25 ºC and a 12-hour photoperiod. The evaluations were carried out daily, and the seeds that presented root with length equal or over 1,0 mm were considering germinated. The RPSI was calculated according to the formula proposed by Maguire (1962) and the percentage of normal seedlings according to the criteria set in the Seed Analysis Rules (BRASIL, 2009).

For the seedling emergence and seedling emergence speed index tests, 50 seeds were sown in four replications for each treatment, in trays containing a mixture of soil and sand in a 1:1 ratio. The sowing depth was 1 cm and the trays were kept in a vegetable growth chamber, previously set at 25 °C in alternate light and dark periods (12h), and the trays were watered whenever needed. After emergence, daily evaluations were carried out, calculating the number of seedlings emerged until stabilization. The emergence speed index was calculated according to the formula proposed by Maguire (1962). The percentage of seedling emergence was calculated from the number of normal seedlings at the end of the experiment.

The experimental design was fully randomized, in a 3 x 3 x 2 factorial design, with: three lots of low, medium and high physiological quality; two types of coating (sand + microcellulose 2:1 and sand + microcellulose + Explosol 4:2:1) plus the control (not pelleted), with and without osmopriming. The variance analysis was carried out using the statistical program Sisvar (FERREIRA, 2011), and the means compared using the Tukey test, p<0,05.

RESULTS AND DISCUSSION

Table 1 shows the data referring to the summary of the variance analysis for the results of germination tests (GT), root protrusion speed index (RPSI), seedling emergence (SE) and seedling emergence speed index (SESI).

Table 1. Summary of experiment III analysis – Influence of physiological conditioning in pelleted *Urochloa brizantha* seeds, with data obtained from germination test (GT), root protrusion speed index (RPSI), seedling emergence (SE) and seedling emergence speed index (SESI), Lavras, MG, 2016.

SV	DF	Mean squares			
		GT	**RPSI**	**SE**	**SESI**
Lot	2	19357,7222**	424,7585**	19137,3889**	144,7709**
Cond.	1	6752,0556**	411,3436**	7285,7222**	81,0819**
Rev.	2	2964,5000**	106,5873**	3556,0556**	28,0750**
L x T	2	210,6389**	38,9260**	564,7222**	6,9951**
L x R	4	388,5000**	32,8996**	429,0556**	4,5435**
T x R	2	68,1667ns	18,6954**	347,3889**	5,2124**
L x T x R	4	147,4167*	8,6620**	186,8889*	1,7591**
Error	54	49,2778	1,4156	57,5741	0,4354**
CV	15,48	15,48	20,10	18,35	19,30

* e ** Significant in the F Test at 5% and 1% of probability, respectively
ns not-significant in the F Test at 5% of probability.

In general, pelleting affected the percentage of seed germination regardless of the lot quality. The exception was the lot with medium physiological quality without osmopriming which did not present differences between the seeds coated with sand + microcellulose and those uncoated (Table 2). These results confirm those obtained by Nascimento et al. (2009) who reported lower germination of pelleted carrot seeds when compared to uncoated seeds. However, they differ from the results obtained by Caldeira et al. (2016) who reported that pelleted tobacco seeds had the germination process delayed when compared to uncoated seeds, but resulted in similar or even higher final germination percentage (SANCHES et al., 2014).

Although pelleting promotes several benefits to the seeds, it can affect germination of several species due to the barrier imposed by the material, hampering the emission of primary roots and the exchange of gases between the seed and the external environment (NASCIMENTO et al., 2009; LOPES & NASCIMENTO, 2012).

Table 2. Germination mean values (%) of three lots of *U. brizantha* cv. Marandu seeds with different levels of physiological quality (low, medium and high), with and without osmopriming and pelleted with two types of material: sand + microcellulose (S+M) and sand + microcellulose + Explosol® (S+M+E), Lavras, MG, 2016.

Pellet	Germination (%)					
	Low		Medium		High	
	without cond.	with cond.	without cond.	with cond.	without cond.	with cond.
Control	26 Ab	42 Aa	64 Ab	90 Aa	77 Aa	85 Aa
S+M	2 Ba	6 Ba	59 Ab	71 Ba	47 Bb	63 Ba
S+M+E	1 Ba	0 Ba	36 Bb	65 Ba	40 Ba	46 Ca

Means followed by the same small letter in the line and capital letter in the column were not different one from another in the Tukey test, at 5% de probability.

Regarding the low physiological quality lot, the osmopriming was seen to be efficient only in promoting the increase in germination of the seeds without pelleting. It was also noticed that the two materials used in the pelleting highly affected the seed germination. In addition, no statistical difference was observed regarding the percentage of germination between the two materials used for pelleting. In a five-year survey on pelleting carried out by Topseed Seeds, Silveira (1997) reported that seeds destined to pelleting should present high germination and high vigour. He also informed that seeds with low germination were not suitable because they made the process uneconomical, cancelling the basic benefits of pelleting, since they would have difficulties to break the coating (pellet).

When considering the medium physiological quality lot, it was seen that the osmopriming was efficient to improve the seed performance in relation to the germination percentage, regardless of the pelleting material used. The increase in germination percentage of KNO_3 osmoconditioned seeds might have occurred as a result of the greater availability of mineral nutrients, nitrogen and potassium, to the seeds (GHOBADI et al., 2012). In addition, KNO_3 might increase the nitrate reductase enzyme activity, increasing the total protein amount (LARA et al., 2014) which might influence the cell membrane permeability (PREECE & READ, 1993), favoring the interchange of substances between the cells and the environment around them, increasing the cell metabolism, mainly of carbohydrates (PREECE & READ, 1993).

Table 2 also shows that the seeds without osmopriming were more affected in their germination when pelleted with sand + microcellulose + Explosol® when compared to the uncoated seeds or those coated with sand + microcellulose, which did not present significant differences one from another. Regarding conditioned seeds, the superiority of uncoated seeds was verified when compared to the coated ones.

As regards the high physiological quality seeds (Table 2), the osmopriming was seen to provide significant increase in germination only when the seeds were pelleted with sand + microcellulose. In addition, it was seen that the pelleting materials sand + microcellulose and sand + microcellulose + Explosol® did not differ one from another regarding the percentage of germination when the seeds were not submitted to physiological conditioning. However, when the pelleting materials were compared with the control, significant difference was observed.

For osmoconditioned seeds, it was seen that the pelleting with sand + microcellulose + Explosol® was more damaging to the germination than when sand + microcellulose was used. However, seeds pelleted with sand + microcellulose obtained lower germination than the uncoated ones. The type of material used for pelleting the seeds might affect directly and indirectly the seed physiological quality, and might prevent the exchange of gases and humidity between the seed and the environment (TONKIN, 1979). Silva & Nakagawa (1998), when testing several filling materials for seed pelleting, concluded that the use of microcellulose and fine sand substrates obtained the best results in lettuce seed germination.

Thus, the negative effect of pelleting on germination in most treatments in this study is probably due to the limited availability of oxygen to the seeds, and also that the pellet might have acted as a mechanic barrier. In this sense, the works of Sachs et al. (1981) showed that the sweet pepper seed germination was inhibited after coating. According to those authors, the final results indicated that high concentrations of oxygen are needed to keep a high metabolic level of germination in pelleted seeds, from the beginning of soaking to the root elongation. This might occur, mainly, as a function of the coating material used, which somehow seems to limit the water oxygen when it goes through it to reach the seed.

Considering the root protrusion speed index (Table 3), no superiority of the low physiological quality lot was seen when the seeds were submitted to conditioning and compared to the uncoated seeds.

For Parera & Cantliffe (1994) the conditioning technique is only efficient in high quality seeds. However, Hussian et al. (2013) and Hussian et al. (2014) demonstrated that the conditioning can invigorate seeds of low physiological quality.

Regarding pelleting, both materials used were seen to influence negatively the root protrusion speed index of the seeds, when compared to the uncoated control. These results confirm those obtained by Medeiros et al. (2006) and Santos et al. (2010), in which the *Daucus carota* L. and *U. brizantha* seed germination speed index was reduced when the seeds were pelleted.

Table 3. Mean values for the root protrusion speed index (IVPR) of three lots of *U. brizantha* cv. Marandu seeds with different levels of physiological quality (low, medium and high), with and without osmopriming and pelleted with two types of material: sand + microcellulose (S+M) and sand + microcellulose + Explosol® (S+M+E), Lavras, MG, 2016.

Pellet	Root protrusion speed index					
	Low		Medium		High	
	Without	With	Without	With	Without	With
Control	2,33 Aa	3,81 Aa	9,66 Ab	18,71 Aa	13,30 Ab	15,06 Aa
S+M	0,09 Ba	0,26 Ba	5,95 Bb	9,81 Ba	4,64 Bb	8,49 Ba
S+M+E	0,02 Ba	0,00 Ba	3,08 Cb	5,34 Ca	3,23 Ba	2,73 Ca

Means followed by the same small letter in the line and capital letter in the column did not differ one from another in the Tukey test, at 5% probability.

Regarding the medium physiological quality seed lot, the results indicated that the conditioning increased the root protrusion speed of seeds with and without pelleting.

Considering pelleting, it was seen that it influenced the root protrusion speed of seeds negatively, similarly to what had occurred with the low physiological quality seeds. However, the seeds pelleted with sand + microcellulose germinated faster than those pelleted with sand + microcellulose + Explosol®.

The osmopriming was seen to be efficient to improve the seeds performance in the high quality lot in relation to the root protrusion speed, except for the seeds pelleted with sand + microcellulose + Explosol®. Once more the seeds that had not been pelleted presented better results when compared to the coated ones, indicating that pelleting affects the root protrusion speed of seeds.

When the two pelleting materials were compared, sand + microcellulose and sand + microcellulose + Explosol®, it was seen that they did not present significant differences from the uncoated seeds. However, in conditioned seeds, the pelleting with sand + microcellulose provided greater root protrusion speed. The reduction in germination and in the root protrusion speed index of pelleted seeds with sand + microcellulose + Explosol® in most treatments, when compared to those pelleted with sand + microcellulose, might be due to the greater limitation of oxygen flow, imposed by this combination of materials. Throughout the experiment, it was seen that this material, when in contact with humidity, tend to form a mass without resistance, covering the seeds, probably for the presence of the explosol used, which might have been responsible for the low oxygen availability to the seeds.

Tonkin (1979) emphasized the importance of the material used to coat seeds, specifying that it should not disintegrate during soaking, forming a mass without resistance, which would limit the flow of oxygen and, in some cases, humidity to the embryo, factors that are necessary during germination. Santos et al. (2010) verified that the *U. brizantha* cv. Marandu seeds pelleted with sand showed greater easiness in the root protrusion than with other materials, which were more hygroscopic, and in which the seeds were in contact with water for longer periods of time, hampering the oxygen absorption by seeds coated with this material.

It seems relevant to emphasize, in general, that the results observed for the root protrusion speed index were similar to those verified in the germination test.

As for the percentage of seedlings emergence (Table 4), low physiological quality seeds showed similar response to that verified in the germination test (Table 2). Conditioned seeds presented superiority regarding the percentage of seedling emergence when compared to the non-conditioned seeds, only when these were not pelleted. The pelleting materials sand + microcellulose and sand + microcellulose + Explosol® did not differ statistically one from another regarding seedling emergence. However, when these treatments were compared to the control, non-pelleted samples, the latter was seen to present higher emergence.

Table 4. Mean average values for the seedling emergence of three lots of *U. brizantha* cv. Marandu seeds with different levels of physiological quality (low, medium and high), with and without osmopriming and pelleted with two types of materials: sand + microcellulose (S+M) and sand + microcellulose + Explosol® (S+M+E), Lavras, MG, 2016.

Pellet	Seedling emergence (%)					
	Low		Medium		High	
	without	with	without	with	without	with
control	19,00 Ab	30,00 Aa	66,50 Ab	83,00 Aa	70,00 Ab	82,50 Aa
S+M	0,00 Ba	0,50 Ba	26,00 Bb	61,50 Ba	12,00 Cb	42,00 Ca
S+M+E	0,50 Ba	4,50 Ba	59,00 Ab	73,00 ABa	56,00 Ba	58,50 Ba

Means followed by the same small letter in the line and capital letter in the column did not differ one from another in the Tukey test, at 5% probability.

In relation to the medium physiological quality seeds, the osmopriming was seen to provide increase in the seedling emergence, both for the pelleted and non-pelleted seeds. It seems relevant to highlight that similar response was seen in the germination and in the germination speed index tests. These results confirm the assumptions by Govinden-Soulange & Levantard (2008), who reported that the use of germination enhancing products and osmopriming were indirectly related to the action of the pelleting layer, since they were attempts to overcome the barrier imposed by the pellet.

Regarding seed pelleting, regardless of conditioning, the uncoated seeds did not differ from those pelleted with sand + microcellulose + Explosol® and these, in turn, presented better results than the seeds pelleted with sand + microcellulose.

It seems important to emphasize that the response presented by the seeds pelleted with sand + microcellulose and sand + microcellulose + Explosol® regarding seedling emergence, was different from that presented in the germination and root protrusion speed index tests.

Also in Table 4, the physiological conditioning was seen to be improved with the performance of the lot with high physiological quality seeds in relation to seedling emergence, except for the seeds pelleted with sand + microcellulose + Explosol®, which did not present significant differences regarding conditioned and non-conditioned seeds. As for the seed pelleting material, higher percentage of seedling emergence was seen in the non-pelleted seeds, followed by those coated with sand + microcellulose + Explosol® and, finally, those coated with sand + microcellulose, which might have occurred due to the presence of soil in this test. Somehow, the soil did not allow that mass without resistance originated from the pellet contact with humidity to be in contact with the seed for a long time, making enough oxygen available to the germination of seeds and seedling emergence.

The mean results of emergence speed index are presented in Table 5. The osmopriming was seen not to be able to increase the speed of seedling emergence with low physiological quality seeds, regardless of being pelleted or not. Parera & Cantliffe (1994) had already suggested that highly vigorous seeds would be a pre-requisite to obtain good results from the osmopriming. Regarding the coating material, pelleting was seen to influence negatively the seedling emergence speed. It seems relevant to emphasize that these results were similar to those verified in the germination, root protrusion speed index and seedling emergence tests.

Table 5. Mean values of emergence speed index of three lots of *U. brizantha* cv. Marandu seeds with different levels of physiological quality (low, medium and high), with and without osmoconditioning and pelleted with two types of material: sand + microcellulose (S+M) and sand + microcellulose + Explosol® (S+M+E), Lavras, MG, 2016.

Pellet	Emergence speed index					
	Low		Medium		High	
	without	with	without	with	without	with
control	1,33 Aa	1,88 Aa	6,46 Ab	8,22 Aa	6,23 Ab	8,53 Aa
S+M	0,00 Ba	0,08 Ba	1,72 Cb	5,01 Ba	0,82 Cb	3,47 Ba
S+M+E	0,08 Ba	0,28 Ba	4,33 Ba	5,14 Ba	4,17 Ba	3,79 Ba

Means followed by the same small letter in the line and capital letter in the column, did not differ one from another in the Tukey test, at 5% probability.

For seeds with medium and high physiological quality, the osmopriming was seen to improve the seedling emergence speed, except for the seeds pelleted with sand + microcellulose + Explosol® whose performance, regardless of being conditioned or not, was similar.

The pelleting material was observed to have better performance regarding seedling emergence speed in uncoated seeds, regardless of being conditioned or not. *U. brizantha* seeds, when pelleted, presented lower performance in vigour tests when compared to uncoated seeds (SANTOS et al., 2010; PEREIRA et al., 2011;).

However, in both the medium and high physiological quality seeds, when conditioned, the different materials used to pellet the seeds did not differ one from another regarding the seedling emergence speed index. However, this was not observed in non-conditioned seeds, with those pelleted with sand + microcellulose + Explosol® presenting higher increase in the seedling emergence speed when compared to those pelleted with sand + microcellulose.

CONCLUSIONS

Pelleting *Urochloa brizantha* cv Marandu seeds with the coating materials used in this study affects negatively the germination final percentage, the root protruding speed index and the seedling emergence and emergence speed index;

Physiological conditioning is efficient to minimize the effects of pelleting, mainly in medium physiological quality seeds.

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