Physiological quality of *Urochloa* seeds treated with thiamethoxam

Qualidade fisiológica de sementes de *Urochloa* tratadas com tiametoxam

Andreia da Silva ALMEIDA[1]; Geison Rodrigo AISENBERG[2]; Cristiane DEUNER[3]; Géri Eduardo MENEGHELLO[4]; Francisco Amaral VILLELA[5]

[1] Autor para correspondência (Corresponding author); Bióloga, Dra., Bolsista CAPES PNPD. Universidade Federal de Pelotas, Faculdade de Agronomia Eliseu Maciel, Departamento de Fitotecnia, Campus Universitário s/nº, Pelotas – RS, CEP: 96.010-900, Caixa Postal: 354; andreiasalmeida@yahoo.com.br

[2] Engenheiro Agrônomo, Bolsista CAPES, Mestrando PPG em Ciência e Tecnologia de Sementes, Faculdade de Agronomia Eliseu Maciel, Universidade Federal de Pelotas, geisonaisenberg@hotmail.com

[3] Engenheira Agrônoma, M. Sc., Doutoranda PPG em Ciência e Tecnologia de Sementes, Faculdade de Agronomia Eliseu Maciel, Universidade Federal de Pelotas, cdeuner@yahoo.com.br

[4] Engenheiro Agrônomo, Doutor, Faculdade de Agronomia Eliseu Maciel, Departamento de Fitotecnia, Universidade Federal de Pelotas, gmeneghello@gmail.com

[5] Professor Doutor, Bolsista Produtividade em Pesquisa do CNPq, Faculdade de Agronomia Eliseu Maciel, Departamento de Fitotecnia, Universidade Federal de Pelotas, francisco.villela@ufpel.edu.br

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Abstract

The product thiametoxam has shown positive effects as increased expression of vigor and biomass formation, raising the photosynthetic rate and formation of deeper roots. The objective of this study was to evaluate the effect of seed treatment with the insecticide thiamethoxam in seeds of *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés. For this purpose, seeds of the cultivar Marandu and Xaraés which were treated with thiamethoxam bioactivator at doses of zero, 100, 200, 300, 400 and 500 mL 100 kg^{-1} of seeds. The evaluation of physiological seed quality Urochloa occurred by conducting germination tests, cold test, accelerated aging, seedling length, length of shoot and root length, and emergency field will. The use of thiamethoxam positively affects the physiological seed quality *Urochloa*. The dose range of thiamethoxam which allowed obtaining the best quality physiological to the two cultivars of *Urochloa* extends from 230 to 280 mL 100 kg^{-1} seeds.

Additional keywords: bioactivator; germination; vigor.

Resumo

O produto tiametoxam tem demonstrado efeitos positivos como na formação de raízes mais profundas, na elevação da taxa fotossintética e no acúmulo de fitomassa das plantas. O objetivo deste trabalho foi avaliar o efeito do tratamento químico com o inseticida tiametoxam, sobre a qualidade fisiológica de sementes de *U. brizantha*. Para tanto, foram utilizadas sementes das cultivares Marandu e Xaraés, as quais foram tratadas com o bioativador tiametoxam nas doses de zero, 100, 200, 300, 400 e 500 mL 100 kg^{-1} de sementes. A avaliação da qualidade fisiológica das sementes de *Urochloa* deu-se por meio dos testes de germinação, primeira contagem da germinação, teste de frio, envelhecimento acelerado, comprimento total de plântula, comprimento de parte aérea e radicular e emergência de plântulas em casa de vegetação. O uso do tiametoxam afeta positivamente a qualidade fisiológica de sementes de *Urochloa*. A faixa de dose do tiametoxam que permitiu a obtenção da melhor qualidade fisiológica para as duas cultivares estende-se de 230 a 280 mL 100 kg^{-1} de sementes.

Palavras-chave adicionais: bioativador; geminação; vigor.

Introduction

Livestock is one of the most important economic activities in Brazil. It is estimated that the area planted to pasture is of 259 million hectares, 144 million of these in native pastures, and 115 million in cultivated pastures. In the latter category, the predominance of *Brachiaria* genus Poaceae are highlighted (KARIA et al., 2006).

The *Brachiaria* genus is now known taxonomically as *Urochloa* genus (RODRIGUES-DA-SILVA & FILGUEIRAS, 2003). The *Urochloa* genus has imposed itself for the remarkable establishment ability in acid and poor cerrado soils, and the *Urochloa brizantha* cv. Marandu has recently been serving as an interim solution for animal production in the cerrado (MEDEIROS et al., 2014).

Favorable soil-related climate conditions, adapted cultivars and the dynamism of the sector businessmen favor seed production in Brazil (PARIZ et al., 2010). Furthermore, for a successful establishment of cultivated pasture, the use of high physiological quality seeds is necessary. The use of seeds without knowledge about its quality may lead to the risk of sowing sub-optimal amounts and lead to low plants density per area, allowing competition between weeds, in addition to consequently contributing in pasture degradation (MEDEIROS et al., 2013).

Another factor to consider is pest occurrence, which due to the intensive use of pasture areas and unstable climatic conditions during the growing season, have favored significant increases in the population of pest insects. During the early stages of plant growth, pests can compromise stand and reduce pasture productivity, and damages caused by several *Brachiaria* pests are considered as main bottlenecks in certain regions culture productivity (CORSI, 2005). In this context, insecticides seed treatment emerges as a viable alternative for pests control during the early stages of plant development (CASTRO et al., 2008), besides avoiding possible losses from soil or shoot pests action (MARTINS et al., 2009).

The chemical insecticide seed treatment, as well as fungicides for protecting seeds from pests and diseases, is not a new technology in the production system. However, new molecules and compounds that are emerging contain new properties which are able to induce effects that alter plant metabolism and morphology (OLIVEIRA et al., 2013). The thiamethoxam, neonicotinoid group systemic insecticide, has demonstrated positive bioactivator effect in the increase of photosynthetic rate, biomass synthesis and deeper roots formation (ALMEIDA et al., 2012). Its transport occurs through cells, activating several biochemical reactions, such as the expression of proteins that interact with plant defense mechanisms, thus enabling better plants performance on adverse conditions, such as high temperatures, drought and soil acidity (ALMEIDA et al., 2012). It also promotes plant growth more efficiently, thus allowing higher vigor expression (CLAVIJO, 2008).

The thiamethoxam is able to model the metabolism of pea, corn and soybeans plants (HORII et al., 2007), to increase beans emergence index (PYNENBURG et al., 2011), stimulate antioxidant enzymes synthesis in soybean seedlings subjected to drought condition (CATANEO et al., 2010) and to boost wheat plants growth (PERELLÓ & DAL BELLO, 2011), metabolism and production (MACEDO & CASTRO, 2011).

Thus, the objective of this study was to evaluate the effect of thiamethoxam seed treatment on *Urochloa* seeds physiological quality.

Material and methods

The experiment was conducted in the Didactic Laboratory of Seed Analysis of Eliseu Maciel Faculty of Agronomy, Universidade Federal de Pelotas.

The experimental design was completely randomized with four repetitions, in a factorial 2 × 6 scheme, with two cultivars and six thiamethoxam doses. The *Urochloa* species used in the treatment was *Urochloa Brizantha* Stapf, using Marandu and Xaraés cultivars. The commercial product doses containing thiamethoxam as active ingredient used in the treatments were zero, 100, 200, 300, 400 and 500 mL to 100 kg^{-1} of seeds.

The product was applied at the bottom of a plastic bag with a pipette, and subsequently spread on its walls to a 15 cm height. Subsequently, the seeds were placed inside the bag, closing its "mouth", so that air remains inside it. Then the bag was stirred vigorously until all product was taken out of its inside (NUNES, 2005). After treatment, seeds were placed to dry at 25 °C for 24 hours.

For seeds quality determination, the following analyzes were performed:

Germination (G): Held in plastic boxes (11×11×3.5 cm) with two sheets of blotting paper, moistened with distilled water at a 2.5 proportion to its dry mass, with four 100 seeds repetitions. The boxes were placed in germinator set with an 8 hours photoperiod and 35-20 °C alternating temperatures. The germination count was performed 21 days after treatments sowing (BRASIL, 2009).

Germination first count (GFC): Held jointly with the germination test, recorded the percentage of normal seedlings on the seventh day after the test installation (NAKAGAWA, 1999).

Cold test (CT): Two repetitions with four 50 seeds sub-samples per treatment were used. Seeds were sown on blotting paper, inside plastic boxes (11×11×3.5 cm), and the paper was moistened with distilled water at a 2.5 proportion to the dry paper mass. After seeding, samples were kept in a refrigerator set at 10 °C for seven days. Then, seeds were placed in a germinator set with an 8 hours photoperiod and 35-20 °C alternating temperatures. Normal seedlings count was performed seven days after the test installation, and the results were expressed as a percentage of normal seedlings (BRASIL, 2009).

Accelerated ageing (AE): seeds mass was arranged in plastic boxes (11×11×3.5 cm) on a galvanized wire mesh, which suspends seeds without water contact. In each case, 40 mL of distilled water was added. The boxes containing seeds were maintained at 43 °C for 48 hours (USBERTI, 1990). After the ageing period, two repetitions with four 50 seeds sub-samples for each treatment were seeded in two sheets of paper blotter, in plastic boxes (11x11x3.5 cm) and kept in germination, as described in the germination test. Normal seedlings percentage was determined on the seventh day after treatments sowing.

Seedling (SL), shoot (STL) and root (RL) total length: ten 15 seeds sub-samples were used for each treatment. Seeds were sown in germitest paper rolls moistened with distilled water at a 2.5 proportion to the dry paper mass, and kept in a germinator set with a photoperiod of 8 hours and 35-20 °C alternating temperatures. Seedlings length was measured seven days after sowing and the results were expressed in centimeters per shoot, root and seedling total length (NAKAGAWA, 1999).

Greenhouse seedling emergence (EC): four 50 seeds repetitions were distributed in individual polystyrene trays (Styrofoam) cells containing Plantimax® commercial substrate. The trays were kept in a greenhouse (average temperature of 20 °C and 80% RH), and evaluations were performed seven days after sowing, computing seedlings with 1.0 cm or more length (ALMEIDA et al., 2009). Results were expressed as emerged seedlings percentage.

Moisture content (M): Two 4.5±0.5 g each samples were taken from each treatment and subsequently packaged in metal containers. Sample masses were measured on a precision balance, taking the seeds then to a regulated oven at 105±3 °C temperature. Samples were maintained in an incubator for 24 hours. After drying period, metal containers were placed inside a desiccator until it reached room temperature (25 °C), with seeds dry mass determination performed afterwards (BRASIL, 2009). The calculation of seeds moisture content was given through the equation U (%) = 100(P - p)/(P - t), where U is humidity in percent; P is the lidded container mass plus the humid seed; p is the lidded container mass plus the dry seed; t is lidded container mass.

Statistical analyzes were performed with the use of the "Statistical Analysis System for Windows - WinStat" 1.0 Version (MACHADO & CONCEIÇÃO, 2003). Data obtained were subjected to analysis of variance and, when significant to F test, the averages for the dose quantitative factor were analyzed through polynomial regression.

Results and discussions

Seeds moisture values after its thiamethoxam treatment and after accelerated ageing test completion were not subjected to statistical analysis, serving only as a basis for evaluating moisture behavior (Table 1). Thus, the use of higher thiamethoxam doses on seed treatment did not excessively increase its moisture, comparing to lower doses. Marandu cultivar presented humidity values higher than that of Xaraés, after seed treatment. With thiamethoxam increasing doses, seed moisture content of the two *Urochloa* cultivars showed a variation of only 0.4 percentage points compared to zero dose.

Seed moisture after accelerated ageing test showed little variation, with a difference of not more than 2.0% between the different thiamethoxam doses used in the seeds treatment, and thus, the procedure presented scientific consistency (MARCOS FILHO, 2005).

Table 1 - *U. brizantha* cv. Marandu and *U brizantha* cv. Xaraés seed moisture in function of the thiamethoxam dose applied to the seed treatment and after the accelerated ageing test.

Thiamethoxam dose (mL 100 kg^{-1})	Post-treatment humidity (%)		Post-Accelerated ageing humidity (%)	
	Marandu	Marandu	Xaraés	Xaraés
0	12.6	13.4	23.2	23.2
100	12.9	13.2	23.0	23.0
200	12.7	13.1	22.9	22.9
300	12.6	13.5	23.3	23.3
400	13.0	13.3	23.1	23.1
500	12.9	13.4	23.2	23.2

Analysis of variance indicated interaction between the different doses and cultivars for all variables, except root length.

In both cultivars, germination values increased from thiamethoxam zero dose, with the highest percentage found in the dose of 263 mL 100 kg^{-1} of seeds for cv. Marandu, and 273 mL 100 kg^{-1} of seeds for cv. Xaraés (Figure 1). For cv. Marandu, germination increased by 19 percentage points, and in the cv. Xaraés by eighteen percentage points, compared to untreated seeds.

In cv. Irga 425 rice seeds, thiamethoxam treatment resulted in an increased germination of up to 60% (GROHS et al., 2012). In carrot seeds, thiamethoxam use increased 23 percentage points in this species germination (ALMEIDA et al., 2009).

Thiamethoxam rice seeds treatment accelerates germination by stimulating the enzymes activity, providing a better stand and plants emergence, improving the initial seedlings startup too (CLAVIJO, 2008). In soybean (CASTRO et al., 2008) and corn seeds (WILDE et al., 2007), there was no germination improvement with thiamethoxam use. In addition, thiamethoxam treatment increased the number of abnormal and dead plants, reducing stand (CASTRO et al., 2008).

The minimum germination standard for *Urochloa brizantha* Stapf seeds commercialization is of 60%, according to the normative instruction number 30 of 21 May 2008 (MAPA, 2008). Thus, thiamethoxam use increased germination to a level that meets the standards established by the current legislation, except for *U. brizantha* cv. Marandu cultivar, at a 500 mL 100 kg^{-1} of seeds dose.

At the first germination count, it can be seen that thiamethoxam use in the seeds treatment gave the same increment, of up to 28 percentage points, to the number of normal seedlings for the two cultivars (Figure 2).

On average, for cv. Marandu and cv. Xaraés, from dose zero to the 260 mL 100 kg^{-1} of seeds dose, the first germination count values were increased with thiamethoxam use.

As for the 500 mL dose, normal seedlings percentage was similar to the values obtained by the control treatment. Thus, the use of incorrect or excessive thiamethoxam doses in the seed treatment can adversely affect *Urochloa* seeds germination process.

In the cold test, there was an increase in the percentage of normal seedlings for both cultivars, with an increase of 28 percentage points with thiamethoxam use in the maximum efficiency level dose, compared to the treatment without thiamethoxam (Figure 3).

The maximum dose that gave the highest normal seedlings percentage for cv. Xaraés was of 271 mL 100 kg^{-1} seeds, while it was of 265 mL 100 kg^{-1} of seeds for *cv.* Marandu.

Black oat seeds thiamethoxam treatment caused an increase in the percentage of normal seedlings in the cold test from zero dose, showing an increasing tendency curve, reaching a peak at a 284 mL 100 kg^{-1} of seeds dose (ALMEIDA et al., 2012).

The Marandu and Xaraés cultivars had their germination percentage after accelerated ageing increased by 27 and 29 percentage points, respectively. With *Urochloa* seeds exposure to the accelerated ageing test, its highest vigor level expression was obtained in the Marandu and Xaraés cultivars with the use of 267 and 251 mL 100 kg^{-1} of seeds doses, respectively (Figure 4).

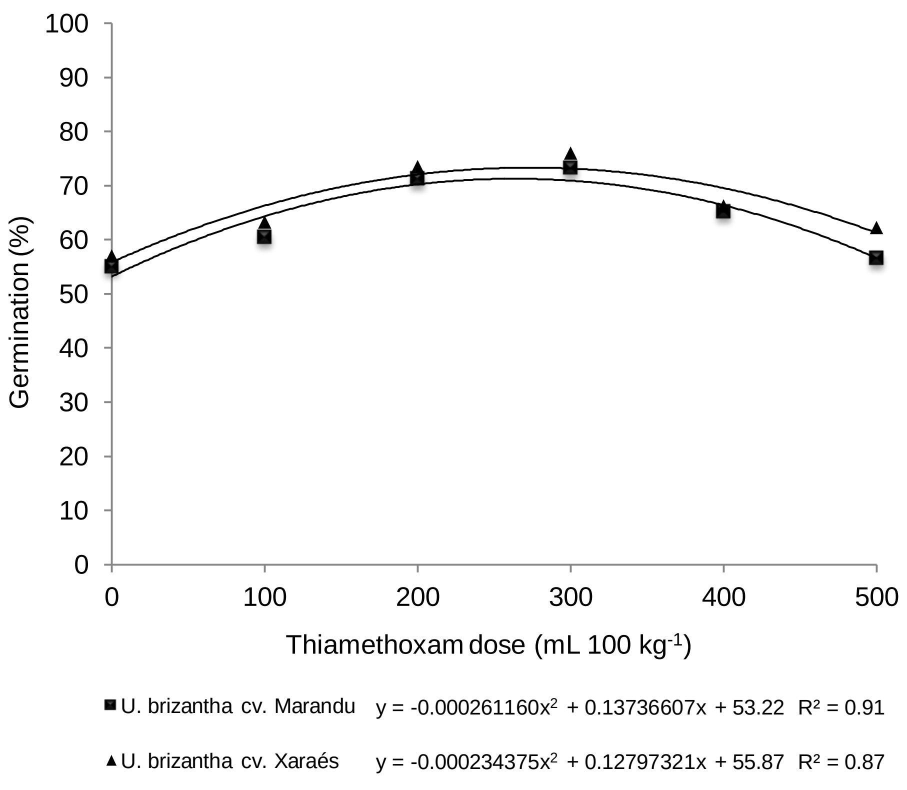

Figure 1 - *U. brizantha* cv. Marandu e *U. brizantha* cv. Xaraés seeds germination in function of the thiamethoxam dose applied in the seeds treatment.

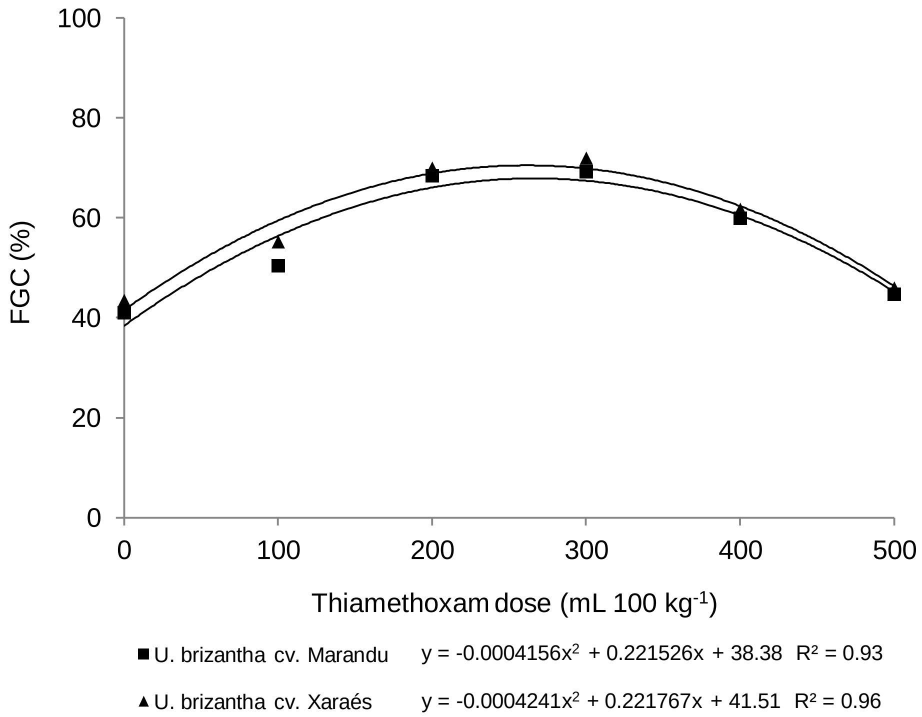

Figure 2 - First *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seeds germination count (FGC) in function of the thiamethoxam dose applied in the seeds treatment.

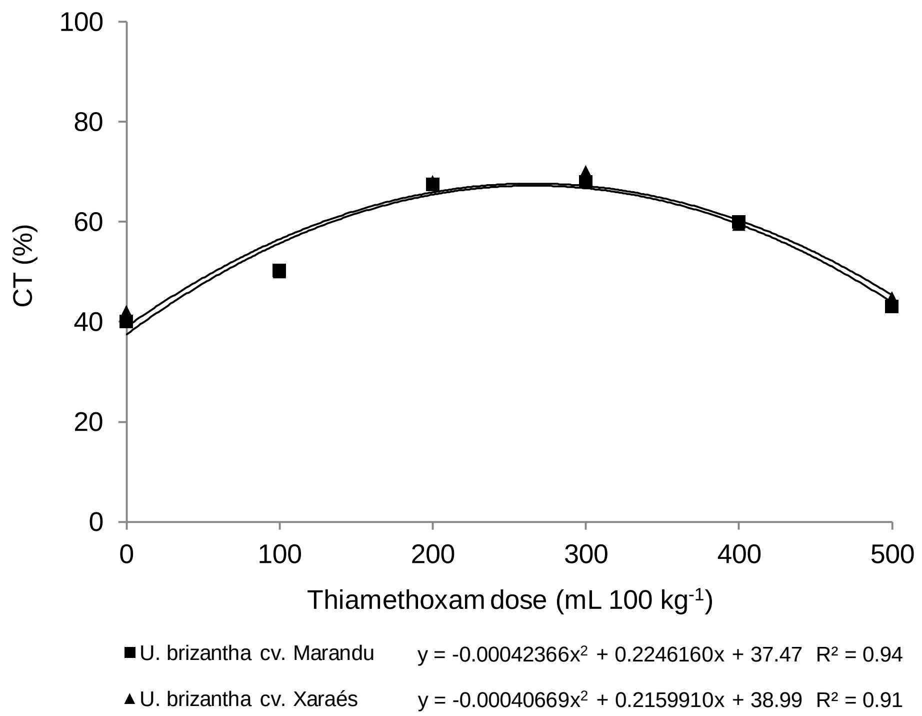

Figure 3 – Cold test (CT) in *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seeds in function of the thiamethoxam dose applied in the seed treatment.

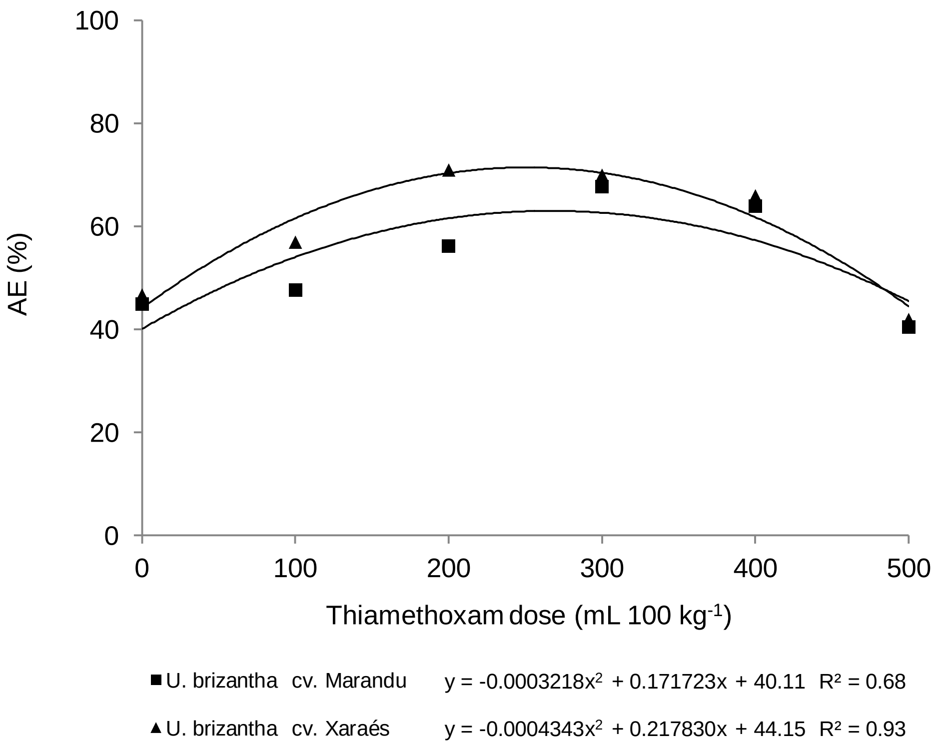

Figure 4 - Accelerated ageing test (AE) in *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seeds in function of the thiamethoxam dose applied in the seed treatment.

In relation to seedlings total length, thiamethoxam use in the treatment of *Urochloa* seeds caused an increase in the overall seedlings size to the 343 mL 100 kg^{-1} of seeds maximum dose for cv. Xaraés. About cv. Marandu, polynomial adjustments were not significant for this parameter (Figure 5).

For both cultivars, the shoot length increased with thiamethoxam use up to a maximum dose of 250 mL 100 kg^{-1} of seeds. After this dose, shoot length was reduced in the two studied cultivars (Figure 6).

Marandu and Xaraés cultivars had an increase in the shoot length of their seedlings, in relation to dose zero, of 2.1 cm. Shoot length with thiamethoxam use, depending on the applied dose, can increase plant stomata absorption and water loss resistance, favoring metabolism and increasing stresses resistance (CASTRO et al., 2008). Additionally, it can increase absorption, transport and nutrients assimilation efficiency (CATANEO, 2008).

Seeds treated with thiamethoxam showed root length increases with dose increase, with the longest length obtained with a 250 mL 100 kg^{-1} of seeds dose. After this dose, root length decreased according to thiamethoxam dose increase (Figure 7).

Root length increase, probably caused by thiamethoxam use in seeds treatment, corroborate the results obtained by ALMEIDA et al. (2011) in rice, ALMEIDA et al. (2009) in carrot and TAVARES et al. (2007) in soybean. Perhaps root increase is the most common physiological effect on plants promoted by thiamethoxam (TAVARES et al., 2007; DENARDIN, 2008; FERNANDES et al., 2008; SILVA et al., 2008).

Thiamethoxam is a molecule with the property of altering *Brachiaria brizantha* metabolism and physiology when applied to seeds, and is able to modify root development and nitrogen absorption, culminating in forage qualitative gains (MACEDO, 2012).

The seedling emergence of the two cultivars was stimulated by thiamethoxam use in the seed treatment, with an increment of 21 and 22 percentage points, respectively, compared to dose zero and to the maximum efficiency dose (Figure 8).

The largest percentage of emerged seedlings in a greenhouse, for both studied cultivars, occurred with the use of 255 and 243 mL 100 kg^{-1} of seeds doses for cv. Marandu and cv. Xaraés, respectively. In bean seeds, increases in the emergence percentage with thiamethoxam use were also observed (PYNENBURG et al., 2011).

In soybean seeds, thiamethoxam application in doses of 100 and 200 mL p.c. 100 kg^{-1} of seeds led to a significant increase in seedling emergence, with adequate moisture situation, and under water deficit (GOULART, 2008).

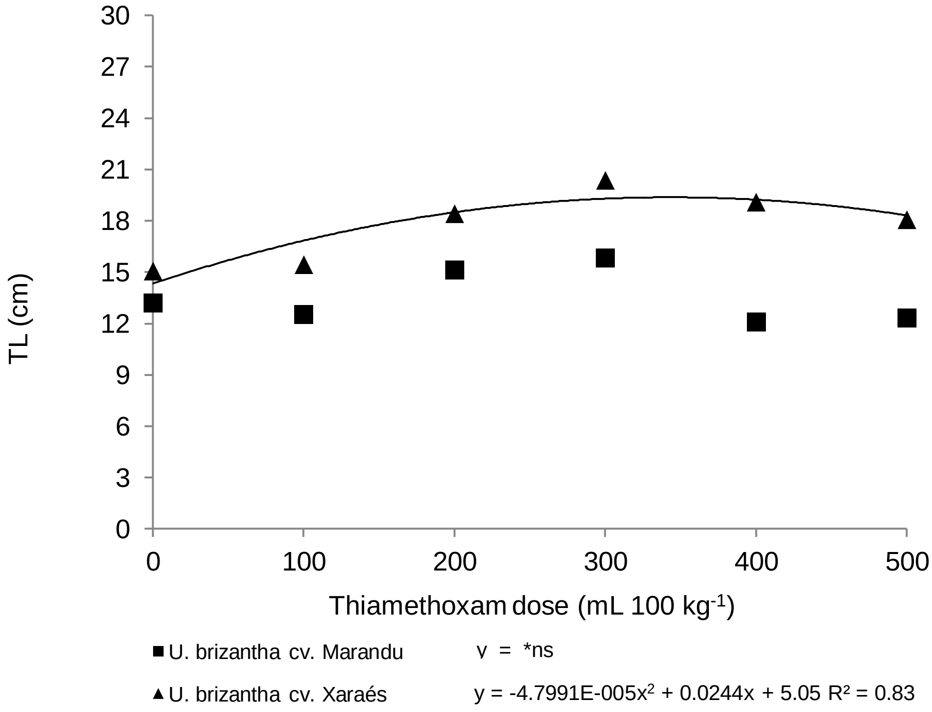

Figure 5 - *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seedlings total length (TL) according to the thiamethoxam dose applied in the seed treatment. * not significant at 5% probability.

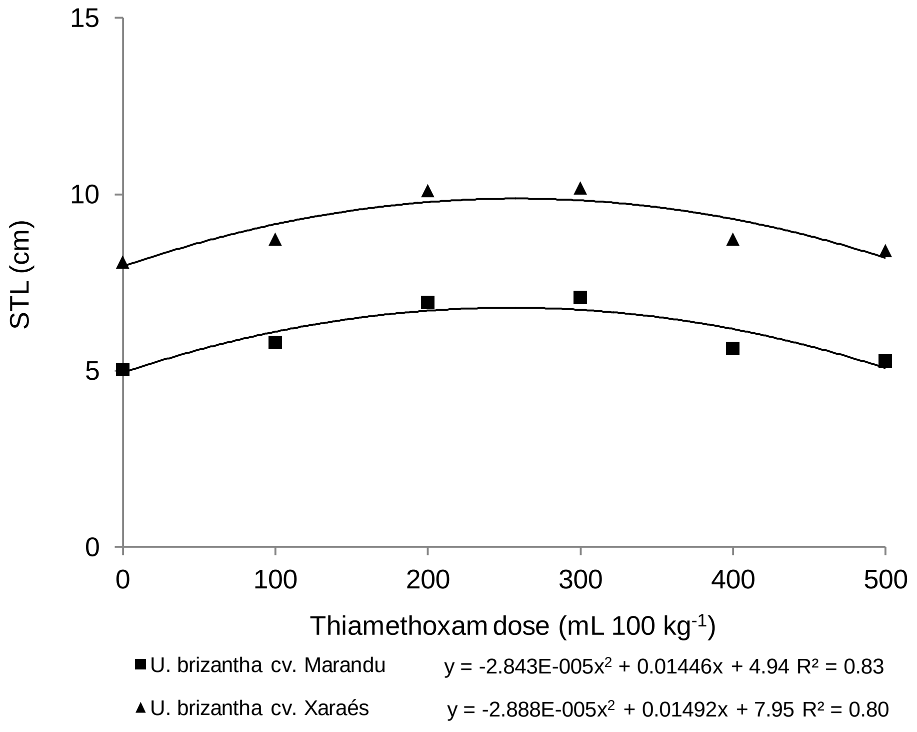

Figure 6 - *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seedlings shoot length (STL) in function of the thiamethoxam dose applied in the seed treatment.

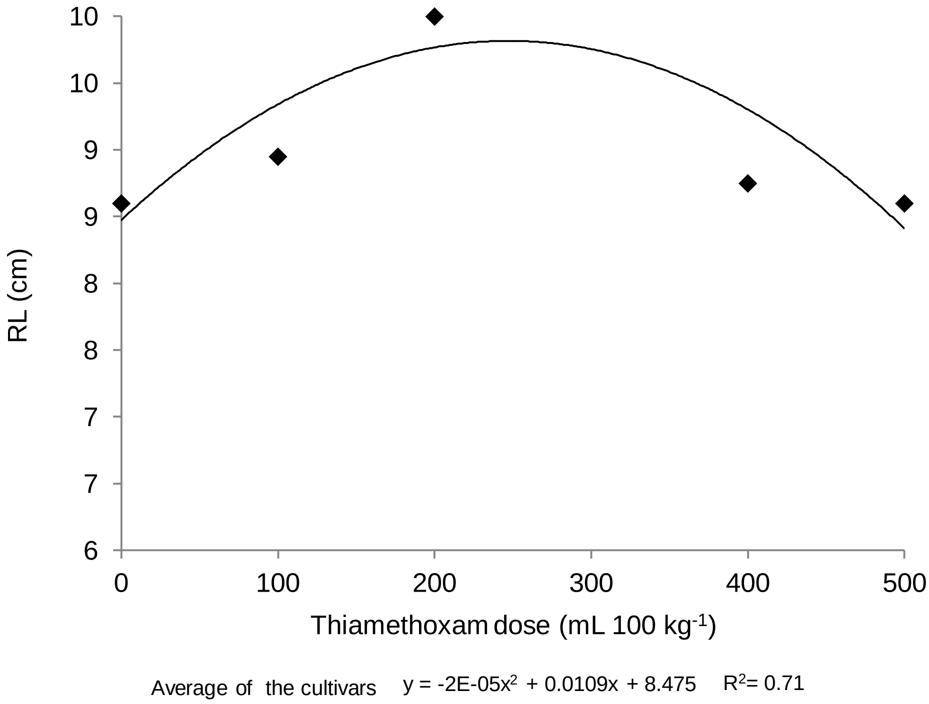

Figure 7 - *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seedlings root length (RL) in function of the thiamethoxam dose applied in the seed treatment.

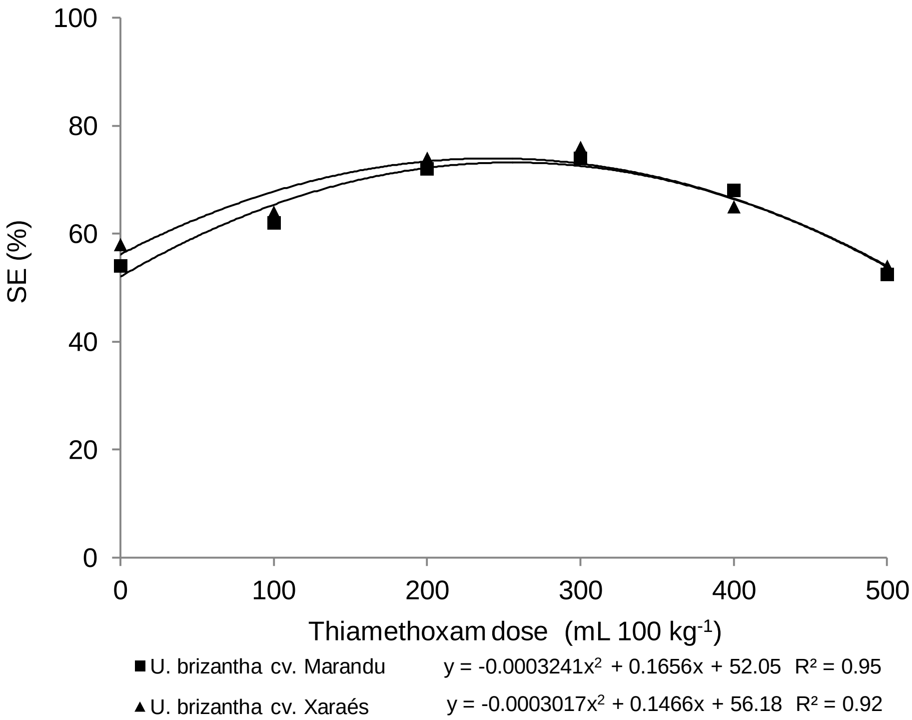

Figure 8 - *U. brizantha* cv. Marandu and *U. brizantha* cv. Xaraés seeds emergence (SE) in function of the thiamethoxam dose applied in the seed treatment.

Soybean seeds treated with thiamethoxam presented higher amino acid levels, enzyme activity and plant hormones synthesis that increase plant responses to these proteins, and these events provide significant increases in production and crop establishment time reduction in the field, as being more tolerant to stress factors (CASTRO et al., 2007; NUNES, 2006).

Thiamethoxam, in certain dosages, can act as a potentiator, allowing seed germination expression, root growth acceleration and plant nutrient uptake enhancement. These thiamethoxam characteristics, allied with high genetic and physiological quality seeds, potentiate the culture production capacity (ALMEIDA et al., 2012).

Conclusions

Thiamethoxam use in seed treatment positively affects the physiological quality of *Urochloa brizantha* Marandu and cv. Xaraés seeds. The thiamethoxam dose range of 230-280 mL 100 kg^{-1} of seeds provided the greatest increases in these cultivars seed quality.

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